Journal of Cultural Economics **19:** 131–155, 1995.

Intellectual Property and Optimal Copyright Protection

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> *"Indeed, one has ample reason to despair of finding a legal tenet that governs the rights of authors and artists. There exists no legal principle by which the state is forced to grant to authors a right in their creation. They cannot claim any right thereupon. This is not to say that the state shall not award such a right. On the contrary, there is every reason to treat them like the most favoured workers, as they deliver a work that is more robust than ashlar, and bring food that does not decay..."*[1]

Abstract. Copyright protection, or more generally, intellectual property rights, can be regarded as a means for the stimulation of production of information goods. This paper analyses the basic problem of production and dissemination of information and the role of copyright protection as an incentive for the producers of creative works. Using a simple model, it is shown that not only a cause for limiting the extent of copyright protection does exist, but that also an argument for a minimum level of protection can be found. Even optimal copyright protection, given the restriction that production and dissemination of information goods has to be co-ordinated by a market mechanism, however, does not lead to a first-best (allocatively efficient) solution. Hence, the judgment that copyright protection is the best solution to the basic problem can be grounded only on a comparative institutional approach.

Key words: Copyright, intellectual property, economic analysis of law

1. Introduction

The Pros and Cons of granting authors property rights in their creations have been discussed for a long time. Even within the legal profession, intellectual property takes an exceptional position. For a long time in the development of legal doctrines towards intellectual property, it was a privilege granted by the authorities (e.g. the king), rather than a legal entitlement, that enabled producers of information to reap the fruit of their work (cf. Wadle [1993]). In 1840, the 'Hoge Raad' of the Netherlands viewed intellectual property rights as an instance of 'benevolence towards authors and artists' (cf. Jehoram [1993]).[2] Therefore, protection of intellectual property, e.g. by means of granting a copyright, seems to have been a matter of favour rather than a matter of principle.

For the economist trained in property rights theory, this discussion seems at first glance to be a little odd. How can there be any doubt about whether a property right in a product, which is valued by consumers and has been produced with a cost to the producers (authors, artists, creators), should be granted? If a copyright is "merely a means by which the author is given a property right on his artistic creation" (Liebowitz [1986:184]) and if "[b]y granting a property right in the resource, private ownership is created which guarantees the most efficient use" (Quaedvlieg [1992]), then one could infer that by means of granting a copyright, production and dissemination of information will be organised in an efficient way, i.e. in a way that maximises social welfare.[3] Unfortunately, this conclusion is unwarranted. To be sure, the specification of property rights is in fact a *sine qua non* for the existence of markets for information. This does not imply, however, that a market mechanism leads to an efficient allocation with respect to information production and dissemination. The characteristics of information (intellectual) goods will inevitably lead to market failure. Thus, no specification of intellectual property rights, protected by a system of copyright, can be judged as (first-best) allocatively efficient. 'Optimal copyright protection', therefore, must necessarily refer to a second-best solution that is defined by maximising welfare, given the restriction that individual decisions have to be co-ordinated via a market mechanism.

Hence, even optimal copyright protection does not necessarily imply the 'best' solution to the problem of information production and dissemination. This judgement can be grounded only on a comparative institutional approach. The copyright solution has to be compared with other institutional arrangements, each with specific virtues and shortcomings.

The paper is organised as follows: the second section sheds light on the basic problem of market-co-ordinated production and dissemination of information. In the third section a model is presented which:

- shows that a market for intellectual goods, backed up by copyright, will not lead to an efficient allocation, and
- deals with the question of optimal copyright protection under the restrictions given by the market mechanism.

The paper concludes with some remarks on the limitations of the model presented in the paper and on the necessity of a comparative institutional analysis.

2. Information and the Market Mechanism: The Basic Problem

To make clear what problems arise with regard to information production and dissemination co-ordinated by a market mechanism, it is useful to distinguish (following Pethig [1988]):

- an information good, e.g. the bible or Verdi's Rigoletto
- an information carrier, e.g. paper/parchment or the material that carries a recording of Rigoletto (e.g. magnetic tape, or vinyl), and

– the specific copy of a work, e.g. the bible standing in the bookshelf or a specific record of Rigoletto.

Dissemination and use of information goods require their combination with an information carrier which yields a copy. Pethig [1988:464] draws the comparison to the bottling of wine, where "[t]he decisive difference is, however, that one and the same information good can be 'filled' in an arbitrarily large number of 'bottles' (= information carriers), whereas the said wine can be racked into a limited number of bottles only with the additional proviso that each bottle contains the same wine but not the same physical units of wine".

Thus, information goods are qualitatively different from 'normal goods'. While, for example, two consumers cannot consume the identical unit of wine, they can consume the identical information good. Information goods are nonrival goods, or put succinctly, public goods (cf. Landes/Posner [1989:326]).[4] Information, once produced, can be used by an additional consumer without additional cost. This is not true for specific copies of a work, i.e., combinations of the information good with information carriers. Information carriers usually are private or semi-public goods. The copy of the bible I am reading cannot be read by another reader at the same time.

With the possibility of separating the information good from the information carrier, nonrivalness allows anybody who possesses a copy to recombine the information good with new information carriers to supply additional copies himself or, in other words, to act as a copier. To take up the metaphor from Pethig [1988]: the content taken from one 'bottle' can be filled in an arbitrarily large number of new 'bottles' by anyone who got hold of a bottle. Thus, copiers compete with the original producer of the information good (and the 'original copies') on the market for copies. If entry to the market is free, this competition will lead to a price for copies that is equal to the copiers' long-run marginal cost for the production of copies. The copiers' marginal cost may be higher than the marginal cost of the original producer because copiers have to separate the information good from one specific information carrier before they can start recombining it with new information carriers.

Even if this price is above the original producers' marginal cost, however, the latter may not be able to recover the cost of creating the information good itself, which only they incur and which copiers do not take into account.[5] Hence, if (potential) producers of information goods expect competition from copiers and therefore a price equal to the marginal cost to copiers, they may lack any incentive to create the work in the first place.

The difference between the marginal cost of producing a copy for original producers and copiers depends on the technology employed by copiers for the separation of the information good from information carriers. This difference decreases as better copying technologies become available. It follows that if copying cannot be prevented by means of the law, this decreasing difference will be reflected in the market price for copies and decreasing profits from the sale of copies for producers

of information. If profits are the incentive for the production of information, fewer works will be created with a corresponding decrease in the difference between the marginal costs to original producers and that of copiers.[6]

Couched in the terms of property rights-theory, the original producer of information, given a technology that results in a prohibitive cost of separation, has a '*de facto* property right' in his creation because he can exclude any potential consumer who is not willing to pay the price charged for a copy. As the producer can price his copies like a monopolistic supplier, he can extract the maximum profit from the sale of copies. This serves as an incentive for the production of the information goods. As technologies for copying develop, however, this *de facto* property right is eroded. To prevent the reduction in the incentives to create works, it has to be replaced by a legally enforced property right, e.g. a copyright that allows only the copyright holder to produce copies by combining the information good with information carriers. Copyright raises the price for the separation and subsequent re-combination of information goods and information carriers, thus compensating for the decrease in the technologically determined costs of copying. As put by Viëtor in the year 1877:[7]

> "By copyright it is to be prevented that the publication of books is left undone. Authors have to be encouraged to enrich the world with the fruits of their quill ... one has to keep in mind the end: to take care of authors being able to earn profits from their work, or to prevent them from not publishing their works due to fear of the opposite case."

While a system of copyright protection can maintain (or even raise) the incentives for the production of information goods, the basic problem remains. On the one hand, copyright prevents (or renders more difficult) competition by copiers. Thereby, the producers of information goods are able to raise the price for copies above marginal cost, thus making profits which cover the fixed costs incurred in the production of the information good (cf. Landes/Posner [1989:328]).[8] On the other hand, an allocatively efficient use of information is inhibited. With nonrivalness in consumption, allocative efficiency requires that all people who wish to consume the information good will, in fact, consume it. Anybody with a positive willingness to pay for the information good should be granted access. Thus, the marginal consumer of the information good should pay a price that is equal to zero *for access to the information good.* This is to say, that the price charged for the marginal copy should equal the production cost of this marginal copy. The production cost of the marginal copy, in turn, comprises the production cost of the (marginal) information carrier, and the cost of combining the information good and the marginal information carrier to a copy.

Without the possibility of price discrimination among consumers, the efficient use of existing information goods would require the price for a copy to equal marginal cost. Consequently, no profits could be earned by selling copies, fixed costs could not be recovered, and no information good would be produced. Com-

petition from copiers, given a highly developed copying technology, would lead to this result.

By granting producers of information goods, e.g. authors, a property right on their creation, they are enabled to earn profits and thus given an incentive to create works. However, this inevitably results in suboptimal use of the information goods, once created.[9] Any attempt to reach an efficient allocation with regard to production and dissemination of information goods by using a market mechanism produces a basic dilemma: the incentives necessary for production necessarily imply suboptimal dissemination. "Put succintly, the dilemma is that without a legal monopoly too little of the information will be produced but with the legal monopoly too little of the information will be used." (Cooter/Ulen [1988:145])

Any system of copyright protection can, at best, be seen as an attempt to balance two welfare losses. While strengthening copyright protection will provide increased incentives for the creation of works, thus lowering the 'social welfare loss due to underproduction', it will at the same time reduce the number of consumers for the information good, thus increasing the 'welfare loss due to underutilization' (cf. Novos/Waldmann [1984]). Keeping the balance, however, is a complicated task. A lot of effects, many of them pulling in opposite directions, have to be traced. Before presenting a formal model which should help to accomplish this task, all interdependencies relevant to the problem are charted in figure 1. The question to be answered with the help of the model is: what intensity of copyright protection maximises social welfare?

3. A Model for the Analysis of Copyright

Since the seminal papers of Plant [1934] and Hurt/Schuchmann [1966], copyright issues have been extensively discussed within an economic framework. The results, however, are nothing more than ambiguous.[10] The question of optimum copyright law has been addressed by Landes/Posner [1989]. To tackle it anew and develop a model that is different from theirs seems to be appropriate, however, as they neglect some aspects of copyright protection which may prove to be important. I want to note explicitly that the focus of the model is on copying by commercial copiers rather than private copying.[11]

For the subsequent discussion it will be useful to distinguish copies supplied by the original producers of information (be it the author or an authorised publisher) and copies supplied by copiers. The former will be referred to as 'original copies' or, for short, 'o-copies' while the latter will be called 'c-copies'. The term 'creator' will refer to the original producers of information.

3.1. Modelling the Effects of Copyright

By having a copyright, producers of information goods are given the opportunity to earn profits through the sale of copies, thereby creating an incentive for the produc-

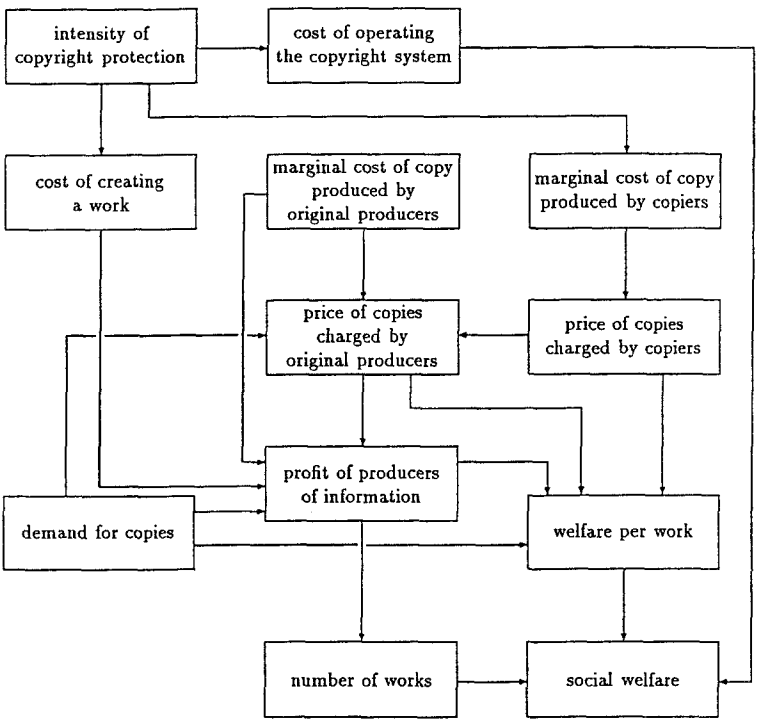

Fig. 1. Maximising social welfare by choosing optimal copyright protection: interdependencies.

tion of information goods. With (potential) competition by copiers the market price for copies will be determined by the marginal costs of copiers. Thus, the extent to which producers of information can earn profits depends on the difference in the marginal costs of producing a copy of the original producers and of the copiers. Let this difference be constant, denoted by the variable k and referred to as the costs of copying. Suppose that creators can produce o-copies at a constant marginal cost of c. Thus, the marginal cost of producing c-copies can be written as $c + k$.[12]

As the purpose of copyright protection is to raise the cost of copying above the level determined by copying technology, the positive effects of copyright protection on the profits earned by creators can be captured by its effect on k. Therefore, the costs of copying are not only determined by the available technology but also by the institutional environment, i.e., by the way the legal order attempts to affect copiers' activities.

For the sake of simplicity we will assume that the effects of a given intensity of copyright protection can be seized by a single variable $\mathcal{P}$,[13] which reflects for example:

- the duration of copyright protection
- the definition of what is to be protected by copyright, i.e., what is to be understood as a copyrightable work

- the exceptions from copyright protection (e.g. a 'fair use'-doctrine)
- the probability of prosecution and punishment of an infringement of copyright
- the size of the sanction for violating copyright, and
- the degree of similarity between o-copies and c-copies that does not constitute an infringement of copyright

The higher the value of $\mathcal{P}$, the higher the cost of copying will be and the higher the marginal production cost of c-copies. Absence of copyright protection will be denoted by $\mathcal{P} = 0$. To simplify the analysis, we will assume a linear relationship between $\mathcal{P}$ and k, that is:

$$k = k(\mathcal{P}) \equiv \kappa + \mathcal{P} \Rightarrow dk/d\mathcal{P} = 1 \tag{1}$$

The variable κ denotes the technologically determined minimal additional cost of production of a c-copy, i.e., the marginal cost to copiers who do not face any copyright protection. $\mathcal{P}$ can be conceived of as the 'implicit price' for copying created by the law.[14] It amounts to the expected cost to copiers who violate the copyright law. We will assume that $\mathcal{P}$ entirely reflects the value of resources used in the process of copying under copyright rather than a pure transfer of money from copiers to the law enforcement authorities.[15]

Copyright protection may not only raise the costs of copying, but also the costs a creator has to incur in the production of the information good. Consider, for example, the case of citation. If there are no exceptions from copyright protection, e.g. by a doctrine of fair use, anyone who would like to refer in his work to the work of others would have to determine the copyright holder, negotiate on the permission to use parts of his work with him, and eventually pay the royalty. Analogously, if copyright will be extended from expressions to ideas, the creation of a new work that does not infringe copyright for existing works would be much harder. This effect of copyright will be discussed in conjunction with the determination of optimal copyright protection.

3.2. The Market for Copies

We consider a market for copies with I potential consumers for each work, indexed by $i = 1 \ldots I$. Information goods (works) are disseminated through the sale of copies, supplied either as o-copies by the creators (authors or authorised publishers) or as c-copies by copiers. Individual willingness to pay for o-copies is distributed uniformly on the interval $[0 \ldots v_{max}]$. For the sake of simplicity, we will assume that maximal willingness to pay (v_{max}) is identical for all works $n = 1 \ldots N$. To capture repercussion effects from the number of available works on the valuation of a given work, let v_{max} depend on the number of works N:

$$v_{max} = v(N)$$

At price p, all consumers whose individual willingness to pay is p or more than p buy a copy. In combination with the assumption of uniform distribution

of individual valuations on the interval $[0 \ldots v(N)]$, this leads to linear demand functions for copies.[16] The number of copies sold at price p is determined by the number of consumers whose willingness to pay exceeds the price charged, i.e., the number of copies sold at price p equals

$$I \cdot \frac{v(N) - p}{v(N)}$$

In contrast to the approach of Landes/Posner [1989], o-copies and c-copies are assumed to be only imperfect substitutes due, for example, to loss of quality in the process of separating the information good from an o-copy to produce c-copies (as compared to the master copy used by creators for the production of o-copies) or a valuation of the very 'authenticity' of o-copies.

To capture this effect, let the valuation of c-copies be a fraction α of the valuation of o-copies ($\alpha \in [0, 1[$). A necessary condition for a consumer buying a c-copy, again, is that the maximum willingness to pay (i.e. αv_i) is greater than the price charged for a c-copy. Consumers buy o-copies rather than c-copies if their net benefit from buying a c-copy (their maximum willingness to pay minus the price charged for a c-copy) is less than their net benefit from buying a o-copy. Thus, if the price charged for o-copies is p^o and the price charged for c-copies is p^c, all consumers with

$$v_i - p^o \geq \alpha v_i - p^c (\geq 0) \tag{2}$$

will buy o-copies rather than c-copies.

Given that c-copies will be bought only if $\alpha v_i > p^c$, this implies that no consumer will buy c-copies if the consumer with the lowest valuation who would buy a c-copy but for the choice between o-copies and c-copies (i.e. the consumer with $\alpha v_i = p^c$) prefers to buy an o-copy at given prices p^o, p^c. Using equation 2, this means that c-copies cannot be sold if

$$p^o \leq \frac{p^c}{\alpha} \tag{3}$$

Hence, at a given price for c-copies p^c, creators can prevent the sale of c-copies by setting $p^o = (1/\alpha) \cdot p^c$. It remains to be shown, however, whether or not the best strategy is for creators to set a price that prevents copiers from entering the market.

O-copies will be bought by all consumers whose individual willingness to pay exceeds the price charge for an o-copy *and* who prefer to buy an o-copy rather than a c-copy if both kinds of copies are offered. Thus, we can look at equation (2) which is binding if c-copies are sold. The condition for buying o-copies rather than c-copies can be written as

$$v_i \geq \frac{p^o - p^c}{1 - \alpha}$$

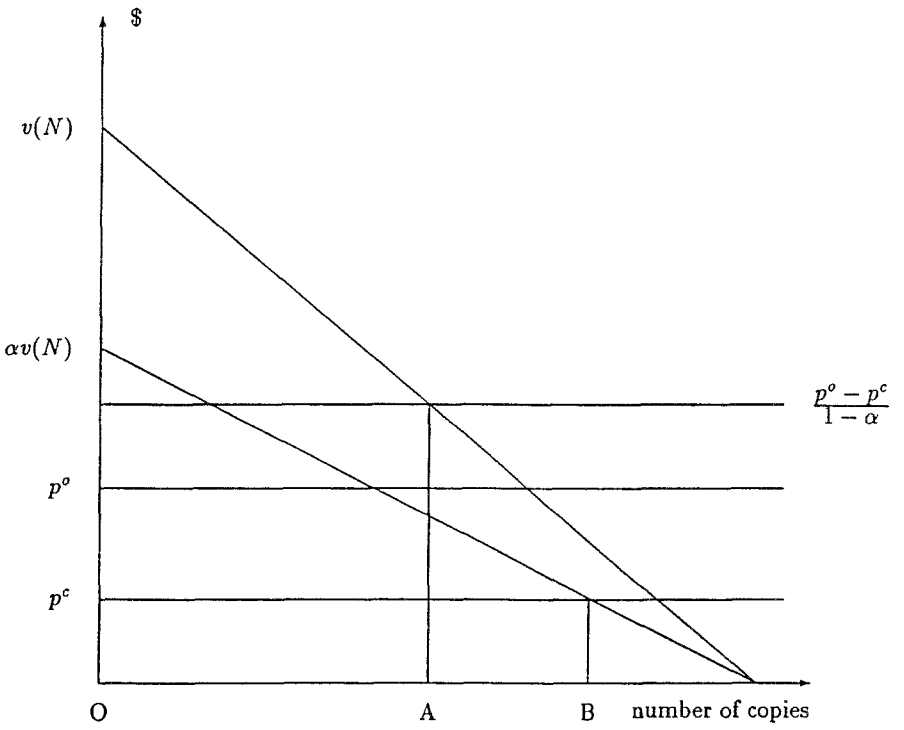

Fig. 2. Supply of o-copies and c-copies at prices (p^o, p^c)

If no c-copies are sold (i.e. if $p^c > \alpha p^o$), the number of buyers of o-copies is limited to those consumers with a positive net benefit and the binding constraint is $v_i > p^o$.[17] Thus, given a combination of prices (p^o, p^c), all consumers with

$$v_i \geq \max\left[p^o, \frac{p^o - p^c}{1-\alpha}\right] \tag{4}$$

will buy o-copies.

A graphical representation is given in figure 2. The total number of copies sold is OB, where OA o-copies are supplied by the creator and AB copies are sold by the copiers.

With homogenous c-copies and free market entry for copiers, the price for c-copies will be determined by the long run marginal cost to copiers: $p^c = c + k$. As k depends on $\mathcal{P}$, this price changes with the intensity of copyright protection. To ease the notation, this dependence will not be written explicitly.

The assumption of constant marginal cost in the production of c-copies together with the assumption of imperfect substitutability constitutes the main difference to the Landes/Posner - model. In their model, the marginal costs of c-copies are

assumed to increase with the number of copies produced, in contrast to the assumption of constant marginal cost for o-copies. The rationale for the assumption of different cost structures given by Landes/Posner [1989:fn 15], however, is not very convincing: "[g]iven our earlier assumption that the author's marginal cost ... is constant, increasing marginal cost for copiers is a necessary assumption; otherwise copiers will produce all copies (in which event, the work will not be created) or no copies (in which event, the degree of copyright protection is not an interesting question."

It will be shown that in the case of imperfect substitutes, o-copies will sell even at a price higher than the price charged for c-copies. Therefore, the assumption of increasing marginal cost for copiers is not necessary to exclude the first problem. More importantly, it will be shown that even if copiers do not actually supply c-copies, i.e., the market is served only by creators, the intensity of copyright protection will be decisive to the creator's decision on the price for o-copies. In fact, the optimal intensity of copyright protection will allow for the prevention of market entry of copiers by setting an appropriate price for o-copies.

Producers of information goods, i.e., the creators, have to consider not only the cost of producing o-copies, but also the cost of creating the work (referred to as 'costs of creation', $\mathcal{C}$).[18] Let $\mathcal{C}_n$ denote the costs of creating work n and let (potentially created) works be ordered in a way such that for two works l and m:

$$\mathcal{C}_l > \mathcal{C}_m \Leftrightarrow l > m$$

These costs are sunk once the work is created. Existing works have the property of nonrivalness or, put another way, they can be consumed by an infinite number of consumers. They can be combined with an infinite number of information carriers respectively. We define the gross profit of creators as the profit from the sale of o-copies of a work they have created, and net profit as gross profit minus the costs of creation.

3.3. Maximising Welfare

First let us consider an ideal world where social welfare is maximised without regard for the mechanism by which the final allocation results from individually optimal decisions. Social welfare (or welfare) is defined as the sum of producer and consumer surplus. In other words, we determine the conditions for an efficient allocation under the assumption that transfers of wealth are possible at no cost.[19]

Given positive costs of copying $k > 0$, welfare will be maximised if and only if all copies sold are o-copies. Copying costs reflect a waste of resources that could be avoided if all copies are produced by creators.[20]

Let w_n denote the welfare from the use of work n. w_n is maximised if the marginal consumer values his copy at $v_i = c$, i.e., his willingness to pay for a copy

covers the cost of producing a copy. Maximal welfare per work then is defined as:

$$w_n^{max} = I \cdot \frac{v(N) - c}{v(N)} \cdot \frac{v(N) - c}{2} - \mathcal{C}_n = I \cdot \frac{(v(N) - c)^2}{2v(N)} - \mathcal{C}_n \tag{5}$$

With identical $v(N)$, total welfare W can be defined as:

$$W = N \cdot I \cdot \frac{(v(N) - c)^2}{2v(N)} - \sum_{n=1}^{N} \mathcal{C}_n \tag{6}$$

Equation (6) can be solved for the optimal number of works $N^\star$. The first order condition is:

$$\frac{\partial}{\partial N}\left[N^\star \cdot I \cdot \frac{(v(N^\star) - c)^2}{2v(N^\star)}\right] = \mathcal{C}_{N^\star} \tag{7}$$

$$\Leftrightarrow I \cdot \left[\frac{(v(N^\star) - c)^2}{2v(N^\star)} + N^\star \cdot \frac{dv}{dN} \cdot \frac{v(N^\star)^2 - c^2}{2v(N^\star)^2}\right] = \mathcal{C}_{N^\star}$$

The first term in square brackets (multiplied by I) captures the increase in welfare due to the creation of an additional work. The second term reflects the effects of an additional work on the welfare created by the stock of existing works. The sign of this second term is determined by the sign of (dv/dN). If the valuation of works decreases with an additional work, then, to maximise welfare, the costs of creation of the marginal work have to be less than the sum of consumer surplus and gross profits $(w_n + \mathcal{C}_n)$. If, on the other hand, an additional work leads to an increase in the valuation of all works, the costs of producing the marginal work have to be greater than the sum of consumer surplus and gross profits.[21]

Note that at this welfare maximum all existing works are used efficiently, i.e., the marginal consumer's willingness to pay equals the marginal cost of producing a copy. Thus, the price paid by the marginal consumer for the use of the *information good* equals zero. It follows that, for the marginal work, the sum of individual valuations equals the costs of creation, corrected for the internalised repercussion effects of the marginal work on the valuation of infra-marginal works.

To reach this welfare maximum through a market mechanism where the decision on the production of information goods is based on the expected profit from the sale of copies, would require at least the marginal producer to perfectly price-discriminate among consumers. Additionally, if $(dv/dN) \neq 0$ and works are supplied by different creators, side payments between the producers must be possible so that the externality the producer of an additional work places on all other producers can be internalised.

If side payments between producers as well as price discrimination is impossible (or, due to reasons of antitrust policy, forbidden), one obtains the following well known result: given externalities and public goods, the market fails in producing the efficient allocation. Thus, whenever the production and dissemination

of information goods has to be organised by the market, this maximum welfare cannot be reached. With a system of copyright protection, perhaps necessary to bring into existence a market for information goods, one can at best hope to get maximum welfare *given the restrictions imposed by using a market.* Therefore, one should keep in mind that even optimal copyright will not bring about theoretically determined maximum welfare. While this caveat may be ignored for the next subsections, it has to be taken into account when one proposes a copyright system as the best solution to the basic problem sketched out in the last section.

3.4. The Supply of Information Goods and the Market Mechanism

Next, we look at a situation where profit-maximising creators decide whether they want to create a work and what price they want to charge for o-copies, given the existence of (potential) copiers with given costs of copying. As noted above, o-copies will be bought by all consumers whose individual valuation satisfies inequality (4). Given the price of c-copies, determined by $c + k$, this inequality yields a kinked linear demand function for the number of o-copies d_o demanded at price p_n:[22]

$$d_o = \begin{cases} I \cdot \dfrac{v(N) - p_n}{v(N)} & \text{for } p_n < \frac{1}{\alpha}(c+k) \\ I \cdot \dfrac{v(N) - \dfrac{(p_n - c - k)}{1-\alpha}}{v(N)} & \text{for } p_n \geq \frac{1}{\alpha}(c+k) \end{cases} \tag{8}$$

Profit maximising creators will sell up to the quantity where marginal revenue equals marginal cost. The optimal price for o-copies will depend on the price for c-copies, which in turn is determined by the costs of copying. Since copyright protection aims at raising the costs of copying, it seems appropriate to determine the optimal price $p_n^\star$ dependent on k. Profit maximising prices are give as

$$p_n^\star = \begin{cases} \dfrac{v(N)+c}{2} & \text{for} \quad k > \dfrac{\alpha v(N) - c(2-\alpha)}{2} \equiv \overline{k} \\ \frac{1}{\alpha}(c+k) & \text{for} \quad k \in [\underline{k}, \overline{k}] \\ \dfrac{(1-\alpha)v(N) + 2c + k}{2} & \text{for} \quad k < \dfrac{(1-\alpha)[\alpha v(N) - 2c]}{2-\alpha} \equiv \underline{k} \end{cases} \tag{9}$$

The interpretation of equation (9) is straightforward: given a degree of substitutability α, creators can set the monopoly price for o-copies, if the costs of copying are above a threshold value $\overline{k}$.[23] They earn monopoly profits as copiers cannot supply c-copies without losses. If the costs of copying are below the lower limit $\underline{k}$, the best strategy for creators is to accommodate copiers who sell c-copies at price $c+k$ and maximise profits, given the residual demand. If, however, the costs of copying

are less than $\overline{k}$ and above $\underline{k}$,[24] creators do best by setting a price for o-copies which prevents market entry by copiers. Thus, creators are the only suppliers, but they do not earn monopoly profits due to the potential competition of copiers. Creators can be said to set a kind of 'limit price', noting that our model does not match the usual model of contestable markets (see e.g. Tirole [1988]).[25]

For creators to enjoy an unthreatened monopoly, the costs of copying must increase as the degree of substitutability increases. Obviously, $\overline{k}$ increases with increasing α. The lower boundary of the interval, in turn, approaches zero if o-copies and c-copies become better substitutes. In the limit case of perfect substitutability, o-copies will be priced exactly like c-copies, $\lim_{\alpha \to 1}(p_n) = c + k$.

Given a low degree of substitutability, $\underline{k}$ and $\overline{k}$ may well become negative. In this case, even with copiers producing c-copies at a marginal cost below c, creators can charge a monopoly price for o-copies.

From equation (9) it can be concluded that increasing costs of copying will lead to increasing prices for o-copies as long as $k \leq \overline{k}$:

$$k \leq \overline{k} \Leftrightarrow \frac{\partial p_n}{\partial k} > 0 \tag{10}$$

With an increasing k the price charged for c-copies must also increase. This becomes relevant only if c-copies are actually supplied, i.e., if $k < \underline{k}$.

Combining optimal prices with the demand function yields maximum gross profits $\pi_n^\star$ to creators:[26]

$$\pi_n^\star = \begin{cases} I \cdot \dfrac{(v(N) - c)^2}{4v(N)} & \text{for} \quad k > \overline{k} \\ I \cdot \dfrac{(c(1-\alpha) + k)) \cdot (\alpha v(N) - c - k)}{\alpha^2 v} & \text{for } k \in [\underline{k}, \overline{k}] \\ I \cdot \dfrac{[(1-\alpha)v(N) + k]^2}{4(1-\alpha)v(N)} & \text{for} \quad k < \underline{k} \end{cases} \tag{11}$$

The profit of creators is increasing in k as long as $k < \overline{k}$, where for $k < \underline{k}$ also the marginal profit:

$$\frac{\partial \pi_n^\star}{\partial k} = I \cdot \frac{(1-\alpha)v(N) + k}{2(1-\alpha)v(N)} > 0 \quad \text{for} \quad k < \underline{k}, \tag{12}$$

is increasing, because

$$\frac{\partial^2 \pi_n^\star}{\partial k^2} = \frac{I}{2(1-\alpha)v(N)} > 0 \quad \text{for} \quad k < \underline{k} \tag{13}$$

while for $k \in [\underline{k}, \overline{k}]$ the marginal profit

$$\frac{\partial \pi_n^\star}{\partial k} = I \cdot \frac{\alpha v(N) - c(2-\alpha) - 2k}{\alpha^2 v(N)} > 0 \quad k \in [\underline{k}, \overline{k}], \tag{14}$$

is decreasing until it becomes zero for $k = \overline{k}$, because

$$\frac{\partial^2 \pi_n^\star}{\partial k^2} = -\frac{2I}{\alpha^2 v(N)} < 0 \quad k \in [\underline{k}, \overline{k}] \tag{15}$$

Assuming that profits are the incentive for the creation of works, the number of works created can be determined endogenously. The creator of the marginal work should earn zero net profit.[27] Let us consider first the extreme case $k > \overline{k}$ where even with creators charging the monopoly price for o-copies, copiers would not enter the market. With maximal profits, the maximum number of works N^{max} will be created where N^{max} is obtained from solving the equation

$$I \cdot \frac{(v(N^{max}) - c)^2}{4v(N^{max})} = \mathcal{C}_{N^{max}} \tag{16}$$

If compared to $N^\star$, the number of works maximising social welfare, it becomes obvious that:[28]

1. profit-maximising creators do not take into account the effect of creating an additional work on the valuation of the stock of existing works, except in the case of all works being created by one single producer;
2. profit-maximising creators do not take into account the increase in welfare due to an additional work but only their profits which are less than the sum of producer and consumer surplus.

The latter does not necessarily imply $N^{max} < N^\star$ since the neglect of additional welfare counteracts the neglect of negative externalities, so that it is possible that too many (as compared to $N^\star$) works are created. If, however, dv/dN is positive or sufficiently small (if negative), then profit maximising creators will create too few works even if rewarded with maximum (monopoly) profits. Thus, a social welfare loss due to underproduction inevitably exists even *without* the profits of creators being eroded by the competition from copiers. Additionally, with monopoly prices, a social welfare loss due to underproduction can be observed.

Now let us consider the opposite case with $k = 0$. When o-copies and c-copies are imperfect substitutes. O-copies will be sold even then at a price above marginal cost. Setting the profit of the marginal creator equal to zero in this case yields the minimum number of works N^{min}:[29]

$$I \cdot \frac{(1-\alpha)v(N^{min})}{4} = \mathcal{C}_{N^{min}} \text{ for } \underline{k} \geq 0 \quad \text{or} \tag{17}$$

$$I \cdot \frac{(1-\alpha)c(\alpha v(N^{min}) - c)}{\alpha^2 v(N^{min})} = \mathcal{C}_{N^{min}} \text{ for } \underline{k} < 0 \quad \text{respectively}$$

Equation (11) shows that profit increases *ceteris paribus* with k. If, however, N is determined endogenously, this does not imply that the number of works increases

with the level of k. To see why, we look at the very work $\tilde{N}+1$ which will not be created at a given level of k, where $\tilde{N}$ refers to the marginal work created. Given $v(\tilde{N})$, an increase in k would lead to an increase in profits, thus making the creation of work $\tilde{N}+1$ profitable. If, however, the maximum willingness to pay for a given work decreases with the number of works, then the necessary condition for the creation of work $\tilde{N}+1$ is that the increased gross profit (due to an increase in k) exceeds $C_{\tilde{N}+1}$ at $v(\tilde{N}+1)$. This condition does not necessarily hold if $dv/dN < 0$. We will assume, however, that dv/dN is sufficiently small for an increase in k leading to an increased number of works created.[30]

Under this assumption, the relationship between costs of copying and creator's profits translates into a relationship between costs of copying and the number of works created:

$$N = \eta(k) : [0, \overline{k}] \rightarrow [N^{min}, N^{max}] \quad \text{with} \quad \frac{d\eta}{dk} > 0 \tag{18}$$

In the analysis of the welfare effects of copyright protection one has to consider not only the number of works created but also the welfare obtained per work, defined as the sum of consumer and producer surplus. Surprisingly, and contrary to the assumption on the impact of copyright protection on welfare that can usually be found in the literature, the welfare obtained per work does not decrease with an increase in k for all values of k. Since the price of o-copies, as well as the price of c-copies unambiguously increases with an increase in k, e.g., due to an increase in the level of copyright protection, most authors like Landes and Posner assume that an increase in the costs of copying is "likely to reduce welfare benefits (consumer plus producer surplus) generated by a given work — assuming it will be created" (Landes/Posner [1989:340]). Even if this effect is plausible, especially if the additional effect of increased copyright protection on the costs of creation is taken into account, the possibility of *increasing welfare per work* due to increasing costs of copying should not be ruled out *a priori*.

For a precise analysis one has to look at the partial derivatives $\partial w_n/\partial k$. It should be noted, that k does affect w_n not only directly, but also by its effects on the number of works and thus, $v(N)$. Assuming that dv/dN is sufficiently small (at least for $k < \underline{k}$[31]), these partial derivatives can be approximated by $\partial w_n/\partial k$ for a constant $v(N)$:

$$\frac{\partial w_n}{\partial k} = \begin{cases} 0 & \text{for} \quad k > \overline{k} \\ -\dfrac{I \cdot (c(1-\alpha)+k)}{\alpha^2 v(N)} & \text{for} \quad k \in [\underline{k}, \overline{k}] \\ \dfrac{I}{4\alpha v(N)} \cdot \left[4c + \dfrac{k(4-\alpha)}{(1-\alpha)} - \alpha v(N)\right] & \text{for} \quad k < \underline{k} \end{cases} \tag{19}$$

The partial derivative is obviously negative for $k \in [\underline{k}, \overline{k}]$. For $k < \underline{k}$, however, the sign is ambiguous. Rearranging terms yields

$$\frac{\partial w_n}{\partial k} > 0 \Leftrightarrow k > \tilde{k} \equiv \frac{(1-\alpha)(\alpha v(N) - 4c)}{(4-\alpha)} \tag{20}$$

Given $\alpha < 1$, the inequality $\tilde{k} < \underline{k}$ holds for $v(N) > c$. Additionally, since for $\underline{k} > 0$, $w_n \mid_{k=\underline{k}} > w_n \mid_{k=0}$,[32] even a decrease in w_n with an increasing k for $k < \tilde{k}$ will be more than compensated for by an increase in w_n with an increasing k until k reaches $\underline{k}$.

The increase in welfare with an increasing k despite increasing prices is due to two reasons:

1. the increase in profits of creators is greater than the loss in consumer surplus because some consumers switch from less-valued c-copies to higher-valued o-copies, if c-copies become more expensive.
2. copying necessarily means that resources are wasted as long as the marginal cost of an o-copy is less than the marginal cost of a c-copy, i.e., creators can produce copies cheaper than copiers.[33]

The maximum welfare per work is reached at the very level of k where copiers cease to supply copies and the whole market is served exclusively by the creators.

3.5. Putting Things Together: Implications for Optimal Copyright Protection

Now that we have seen how different factors relevant to social welfare depend on the costs of copying, some implications for an optimal level of copyright protection can be derived. One has to keep in mind, however, that 'optimal' refers to the best solution which can be reached through a market mechanism.

The level of copyright protection affects the number of works created in two ways:

1. an increase in $\mathcal{P}$ results *ceteris paribus* in an increase in gross profits as long as $k(\mathcal{P}) < \overline{k}$. This in turn leads to an increase in the number of works if dv/dN is sufficiently small.
2. an increase in $\mathcal{P}$ results ceteris paribus in increased costs of creation, which would lead to a decrease in the number of works.

The relative magnitude of these two effects depends on the implementation of copyright, i.e., the scope of protection, the definition of a copyrightable work, and the existence of exceptions from copyright. We will assume that by choice of an appropriate implementation, the dominance of the first effect can be ensured. This is to say that as long as an increase in the level of copyright protection leads to an increase in gross profits greater than the increase in $\mathcal{C}_n$, net profits also increase with $k(\mathcal{P})$.

The optimum level of copyright protection is obtained by solving the following maximisation problem:

$$\max_{\mathcal{P}} \quad \eta(k(\mathcal{P})) \cdot w_n(v(\eta(k(\mathcal{P})), k(\mathcal{P}))) - \mathcal{C}(\eta(k(\mathcal{P})), \mathcal{P}) - E(\mathcal{P}) \qquad (21)$$

$\mathcal{C}(\cdot)$ stands for the aggregate cost of creating works, depending on the number of works and on the level of copyright protection.[34] $E(\cdot)$ refers to the cost of operating a copyright system depending on the level of copyright protection. It seems plausible to assume that these costs increase with the level of copyright protection, i.e., $dE/d\mathcal{P} > 0$.

The first order condition to this maximisation problem is given by:

$$\frac{dk}{d\mathcal{P}}\left[\frac{d\eta}{dk}\left(w_n - \frac{\partial \mathcal{C}}{\partial \eta}\right) + \eta(k(\mathcal{P}))\left(\frac{\partial w_n}{\partial v}\frac{\partial v}{\partial \eta}\frac{\partial \eta}{\partial k} + \frac{\partial w_n}{\partial k}\right)\right] - \frac{\partial \mathcal{C}}{\partial \mathcal{P}} - \frac{dE}{d\mathcal{P}} \stackrel{!}{=} 0 \qquad (22)$$

The first term in square brackets captures the effect of a change in the number of works, valued with the welfare per work. Since the net profit for the marginal work is zero but consumer surplus is positive, this term is also positive as long as the number of works increases with k. The second term captures the change in welfare per work for the complete stock of existing works.

The complexity of equation (22) makes it obvious that the determination of the optimal level of copyright protection is a difficult task and requires law-makers to possess complete information about production technologies and demand structures. Nevertheless, the optimality condition provides some information on the interval in which the optimal level of copyright protection has to be sought.

Equation (22) requires the marginal increase in welfare due to an increase in the number of works (i.e. the reduction of the social welfare loss due to underproduction) to be compensated for by the decrease in welfare per work for all existing works. This must also adjust for the change in the aggregate costs of creation and in the costs of operating the copyright system. Optimum copyright protection, therefore, cannot imply a level of k where the welfare per work, as well as the number of works increases with k. This is the case if $k < \underline{k}$ (given that dv/dN is sufficiently small). The first result, therefore, is: if the costs of operating a copyright system are not prohibitive, optimum copyright protection would require raising the costs of copying to a level where creators have an interest in preventing market entry from copiers by setting the price for o-copies at $(c + k)/\alpha$. Thus, there is an argument for minimum copyright protection.

On the other hand, the intensity of copyright protection should not induce the production of the maximum number of works N^{max}. At N^{max}, the first term in square brackets is no longer positive, so that with a negative second term the optimality condition cannot hold. Optimum copyright protection $\mathcal{P}^\star$, therefore, should imply a level of costs of copying that satisfies:

$$k(\mathcal{P}^\star) \in [\underline{k}, \overline{k}] \qquad (23)$$

A necessary condition for legal intervention into the market for information by granting authors a copyright is $\kappa < k^\star$, where $k^\star$ in turn depends on the possible intervention. A sufficient condition is $W(k^\star) > W(\kappa)$, where $W(k^\star)$ refers to the welfare given a copyright system that leads to $k^\star$.

It is important to recognise that copyright works only in one direction: copyright can serve only as a remedy to a situation where the technologically determined costs of copying are too low compared to the socially optimal level. The welfare analysis presented above, however, would be also valid if $\kappa > k^\star$. The same argument for granting copyright to raise the costs of copying would apply to, for example, subsidising (potential) copiers if the technologically determined costs of copying are too high. Copyright can be an appropriate remedy only if the social welfare loss due to underproduction is too high, not if the social welfare loss due to underutilization is too high.

The most interesting result of the model presented in this paper is that with optimum copyright protection only creators supply copies while not charging monopoly prices. Rather, they face a restriction from the existence of potential copiers. The optimal strategy for creators is to prevent market entry from copiers by setting what may be called a limit price. Thus, they choose a strategy which has been recommended in 1790 as an "infallible means to prevent piracy of books, for the interest of legitimate authors and publishers": to render copying unprofitable, they should sell a second edition, following the first edition, at a low price.[35] In our context, this amounts to setting a price for o-copies at which copiers cannot supply c-copies without making losses.

This effect of copyright protection has to be neglected in the framework proposed by Landes/Posner [1989], as they assume copies to be homogenous. Thus, in their model, a change in copyright protection leads to a change in the price of copies only if there actually is a supply from copiers. In our model, however, changes in $\mathcal{P}$ also have an influence on p_n via k if only creators serve the market for copies.

With regard to the design of copyright, one should notice that the less it affects the costs of creation, the greater its welfare-increasing effect is. Rather, copyright should selectively raise only k. This requirement is met by the definition of copyrightable works, where only expression but not the underlying ideas can be copyrighted. Thus, a copyright holder is not protected against accidental duplication of its work (cf. Landes/Posner [1989:344]. Or, in the words of Judge Learned Hand: "if by some magic a man who had never known it were to compose anew Keats' Ode on a Grecian Urn, he would be an author and, if he copyrighted it, others might not copy that poem, though they might of course copy Keats."[36] This may be seen as an attempt to raise copiers' costs without at the same time raising the costs of creation. The importance of this distinction between ideas and expression becomes obvious if one looks at the problem encountered when copyright is to be applied to new technologies, such as semiconductor protection or computer software. While expression can be relatively easily separated from ideas

in the field of art, the dividing line becomes blurred, if the expression of an idea is technologically determined as in the case of computer software (cf. Menell [1989] or Schmidtchen/Koboldt [1993] with reference to further literature).

The fair use doctrine serves the same purpose: if authors are not allowed to cite parts of copyrighted works without explicit permission from the copyright holder, costs of creation would increase while costs of copying would be affected only very little (cf. Landes/Posner [1989:357 ff.]).

Finally, the costs of operating the copyright system have to be taken into account.[37] Again, the distinction between idea and expression, where only the latter is copyrightable, can be seen as an attempt to economise on the costs of operating the copyright system. No comparison on similarity between a new work and existing works is necessary beyond that concerning identical expression in order to grant a copyright. However, with patents the application has to pass an extensive examination before the patent grant can be issued.

4. Concluding Remarks

Economic analysis of intellectual property law is not without its critics, even among scholars of law and economics:

> "Of course, economic analysis is no more likely to resolve the question of the appropriate scope of substantive criminal law. But the difference between these fields is that there is much greater social consensus ... There is no literature ... addressing whether the prohibition of murder or rape are likely to enhance or diminish the social welfare. There is disagreement, of course, over the details of criminal punishment — the capital punishment debate is an example. But neither those opposing nor, certainly, those favoring capital punishment question whether the prohibition of murder itself is worth the effort. Yet, the analogous question is the principal focus of the debate ... over intellectual property. ... Personally, I believe there is little hope that economic analysis can resolve the question of the appropriate scope of the protection of intellectual property... [T]he influence of the economist on the law of intellectual property will always be limited. The lawyer must look for other sources of guidance." (Priest [1986:24]).

Of course, economic analysis cannot claim to give clear cut prescriptions for how a copyright system should look. However, economic analysis can show that there is something like an optimal, i.e., welfare maximising intensity of copyright protection. It can also indicate on which factors this optimal intensity depends. Furthermore, it can show that neither complete absence of copyright protection nor complete absence of potentially profitable copying are likely to be the optimal solution.

I would like to conclude with a caveat and a plea. The caveat refers to all effects and determinants this paper has ignored.

Firstly, it has not taken into account the dimension of time: Copyrights, distinct from other property rights, usually are temporally limited; therefore, the temporal limitation should be explicitly incorporated into the analysis.

Secondly, maximising social welfare is perhaps not the only end to which the protection of intellectual property rights is targeted. If there are other aims to be promoted by copyright, however, one should always keep in mind that achieving these goals comes with a cost: decreasing welfare.

Thirdly — and this will translate into the plea — there may exist mechanisms that render copyright protection obsolete or imply a reduction in the intensity of protection.[38]

Generally, these alternative institutional arrangements are important because a copyright system can never produce the first best solution for the problem of information production and dissemination. Thus, there is room for other mechanisms to perform better than a system of copyright protection, backing up a market. Even if one does not believe that there are alternative institutional arrangements which perform better than copyright, e.g., a subsidy to creators in combination with a distribution of works at a price equal to the marginal cost of a copy, this has to be proven. Of course, the comparative institutional approach asked for has to compare the arrangements with all their virtues and shortcomings, including their implementation costs. One must not compare 'optimal copyright protection' with a system of subsidies under imperfect information, nor ideal subsidies with actual copyright.

Thus, despite all the work on intellectual property and even a strong belief in the superiority of the copyright solution, Macauley's assertion — presented to the House of Commons in 1841 — still waits for a proof: "[i]t is desirable that we should have a supply of good books; we cannot have such a supply unless men of letters are liberally remunerated; and the least objectionable way of remunerating them is by means of copyright."[39]

Appendix

First we want to show that $\tilde{k} < \underline{k}$ if $a < 1$ and $v(N) > c$. Therefore, we have to check under what conditions the inequality

$$\tilde{k} \equiv \frac{(1-\alpha)(\alpha v(N) - 4c)}{4-\alpha} < \frac{(1-\alpha)[\alpha v(N) - 2c]}{2-\alpha} \equiv \underline{k}$$

to hold.

Multiplying, rearranging and collecting terms yields

$$0 < \alpha(v(N) - c)$$

The latter inequality holds for if $v(N) > c$. ■

Second, it is to be proven that for $\underline{k} > 0$ w_n at $k = \underline{k}$ exceeds w_n at $k = 0$. In this case, we can look at whether the difference $w_n \mid_{k=\underline{k}} - w_n \mid_{k=0}$ is positive.

Welfare per work (the sum of consumer surplus and profits) is given for the interval $[0, \underline{k}]$ as:

$$w_n = \frac{I}{8\alpha v(N)} \cdot \left[v(N)^2(3\alpha + \alpha^2) - v(N)(8\alpha c + 2\alpha k) - 4c^2 + 8ck + k^2 \frac{(4-\alpha)}{(1-\alpha)} \right] - C_n$$

The difference, thus, is given by

$$w_n \mid_{k=\underline{k}} - w_n \mid_{k=0} = \frac{I}{8\alpha v(N)} \left[\underline{k}(8c - 2\alpha v(N)) + \underline{k}^2 \frac{(4-\alpha)}{(1-\alpha)} \right]$$

The sign of this difference depends on whether the term in square brackets is positive, which is the case if:

$$\underline{k} > \frac{(1-\alpha)(2\alpha v(N) - 8c)}{4-\alpha}$$

Employing the definition of $\underline{k}$ from equation (9) one obtains:

$$\frac{(\alpha v(N) - 2c)}{2-\alpha} > \frac{(2\alpha v(N) - 8c)}{4-\alpha}$$

Multiplying and rearranging terms yields:

$$\frac{v(N)}{c} > \frac{6\alpha - 8}{\alpha^2}$$

The term on the left side of this inequality is positive (and greater than one if there is at least one consumer whose willingness to pay for a copy exceeds the cost of producing a copy, i.e. $v(N) > c$). The denominator of the fraction on the right side is positive, but the numerator is negative for all $\alpha \in [0, 1[$. Therefore the fraction on the right hand side is negative or zero, and the inequality holds for all possible values of α and hence also for $\alpha \in]2c/(v(N), 1[$, i.e. for those values of α for which $\underline{k} > 0$ holds. This implies that the difference $w_n \mid_{k=\underline{k}} - w_n \mid_{k=0}$ is positive and therefore, w_n at $k = \underline{k} > 0$ always exceeds w_n at $k = 0$. ■

Notes

* I am indebted to Joshua Bauroth, Karen DeGannes, Björn Frank, Peter Jürgen Joost, Matthias Leder, Wernhard Möschel, Dieter Schmidtchen, Ruth Towse, Georg von Wangenheim, Peter Weise and Christian Wey for helpful comments that have greatly improved the paper. The usual disclaimer applies.

[1] Freeseman Viëtor, Handelingen der Nederlandsche Juristen-Vereeniging, Den Haag, 1877, own translation from Jehoram [1993].

[2] Even today, for example in German civil law (based on the 'Bürgerliches Gesetzbuch') intellectual property, strictly speaking, does not exist. The conception of intellectual property is based on other areas of law, especially on the extensive protection of property granted by the constitution (the Grundgesetz); cf. Klippel [1993].

[3] For example, the 1985 amendment to German copyright law explicitly aimed at granting the copyright holders an adequate share in the exploitation of their works, recognising that intellectual goods are especially prone to a 'taking by third parties without compensation' (cf. Bundestagsdrucksache 11/4929: "Bericht über die Auswirkungen der Urheberrechtsnovelle 1985 auf die Fragen des Urheber- und Leistungsschutzrechtes").

[4] Note that the distinctive feature of a public good is its nonrivalness in consumption rather than the impossibility of exclusion. Nonexcludability defines externalities. Even if nonrivalness and nonexcludability often come in combination, it is important to distinguish these two characteristics. Because information goods can be consumed only via their combination with information carriers, they exhibit the characteristics of pure public goods in contrast to public externalities. Consider for example broadcasting. While the information put out into the air can be consumed by an infinite number of people without diminishing the amount used by each consumer, all people who do not have the equipment necessary to receive the programme are excluded from consumption. For a clear distinction between public goods, private goods, public externalities and private externalities see Russell/Wilkinson [1979:373 ff.].

[5] In the case where original producers have to create an information good under uncertainty about future demand, copiers may have an additional advantage as they have better information about the demand for a given work. In other words, they can selectively copy only successful works. Therefore, the risk borne by copiers is smaller than the risk borne by original producers (cf. Landes/Posner [1989:328]).

[6] See among others Peacock [1979], O'Hare [1982,1985], Novos/Waldmann [1984,1987], Cheung [1986], Kindermann [1987], Tenschert [1987], Thurow [1987], Pethig [1988].

[7] Cited from Jehoram [1993:116] (own translation).

[8] In fact, the production costs for the information goods are sunk costs. The profits represent the stream of quasi-rents necessary to induce the producers to incur the cost of producing an information good. Usually, these terms are replaced by 'fixed costs' and 'monopoly profits'. Even if I will adapt to this terminology, it must be stated that the profits earned by the producers of information goods can be regarded as monopoly profits only to the extent that prices exceed *long run* marginal costs. This is because the difference between short run marginal costs and long run marginal costs would lead to a stream of quasi-rents also in the case of a perfectly competitive market.

[9] For a more general treatment of this phenomenon see von Weizsäcker [1981].

[10] For a typical example of this ambiguity see the discussion about the necessity of copyrights between Breyer [1970] and Tyerman [1971]. Further references to the extensive literature on the copyright issue are given for example by Besen/Raskind [1991] or Koboldt/Schmidtchen [1991].

[11] For a treatment of private copying see Besen/Kirby [1989] or Johnson [1985].

[12] This marginal cost to copiers can be conceived of as the long run marginal cost, which with free market entry will equal the minimum average cost of producing c-copies. Thus, to assume constant marginal cost for copiers is unproblematic, because all costs that are fixed in the short run are captured by $c + k$.

[13] This way of modelling copyright protection may seem too naïve for lawyers who are concerned with the many facets of the implementation of copyright protection. For our purpose, however, it will be convenient to lump together all details of copyright protection that affect the cost of copying. For a similar procedure see Landes/Posner [1989:333 f.].

[14] Cf. Koboldt/Leder/Schmidtchen [1992].

[15] This assumption eases the analysis and can be relaxed without qualitatively changing the results.

[16] Other demand functions can be generated by assuming other distribution functions.

[17] Note that for all $p^o < p^c/\alpha$, $\frac{p^o - p^c}{1-\alpha} > p^o$. Neglecting the constraint $v_i > p^o$ in this case would count as buyers those consumers who would prefer o-copies to c-copies, but get negative net benefits from both kinds of copies, and thus do not buy at all.

[18] As noted above, the costs of creation may also depend on the intensity of copyright protection. For the moment, this relationship will be ignored.

[19] For this assumption, typical for the economic analysis of law, see Polinsky [1983].

[20] Even if the cost of producing a c-copy is less than the cost of producing an o-copy, an exclusive supply of o-copies is preferable as long as the consumer surplus of the marginal consumer is greater if he buys an o-copy rather than a c-copy. Given the efficient amount of consumption of created works, the marginal consumer has an individual valuation $v_i = c$. Thus, if $\alpha v_i = \alpha c < c + k \Rightarrow k > (\alpha - 1) \cdot c$, all copies should be o-copies. Given a sufficiently low degree of substitutability, there should be no supply by copiers even if they can produce copies at a lower cost.

[21] Please note that the endogeneously determined number of works, N^*, can be seen as the *optimal variety* of works. Thus, the model presented here captures the spirit of the Dixit/Stiglitz - model for the determination of optimum product diversity (Dixit/Stiglitz [1977]),

[22] We will drop the superscript o, as it is only the price for o-copies which can be determined by the producers while the price for c-copies is given by $c + k$.

[23] Of course, the situation of creators could be more aptly described as one of monopolistic competition inasmuch as different works from different authors can be seen as close substitutes. This effect, however, can be at least partly captured by the dependence $v(N)$. If $(dv/dN) < 0$, then the individual demand curves become more elastic as the number of suppliers (equivalent to the number of works) increases.

[24] This requires the inequality $\overline{k} > \underline{k}$ to hold. This inequality can be reduced to $v(N) > c$, which holds whenever there is at least one consumer with a maximum willingness to pay for a copy greater than the cost of producing a copy.

[25] It is worth noting that creators can also prevent market entry from copiers if k is below $\underline{k}$ if they can sell copies which are qualitatively equivalent to c-copies at a different price than that charged for o-copies, namely $c + k (< \alpha p_n)$. This would yield an additional profit. For the sake of simplicity, we will ignore this possibility and assume that creators can only supply o-copies (i.e., all copies supplied by creators are homogenous). This simplification does not change the results qualitatively because the influence of k on creators' profits is qualitatively the same regardless of the possibility to sell two kinds of copies.

Nevertheless, a possible extension comes to mind: if creators can produce copies equivalent to c-copies at a lower cost (less than c), a profit-maximising strategy may exist where creators supply two different kinds of copies, even if not threatened by the potential supply of copiers. This for example would match the observation of hard-cover and paperback editions of a work being supplied by the same publisher. But this 'explanation' should be interpreted very carefully, as an adequate analysis of secondary use requires the explicit notion of time to account for such things as the time lag between the hard-cover and the paperback edition.

[26] For copiers, even if they supply c-copies, the zero-profit-condition must hold, as with a free market entry for copiers, supply of c-copies is perfectly competitive.

[27] Of course there may be other motivations for the creation of works, such as, e.g., the desire to express oneself or the desire for recognition by society. Then works would be created even if no money profits can be earned. One can expect, however, that the number of works created due to nonmonetary incentives will be lower than the socially optimal number of works (but see also O'Hare [1989]). It is worth noting that the monetary incentive is present also in the creation of academic works, even if — as we all know — the profits from publication (textbooks aside) are close to zero (perhaps negative). But the creation of academic works may well increase earnings due to increasing reputation.

[28] This resembles the argument for the possible failure of the market to produce the optimum product diversity, employed by Dixit and Stiglitz [1977:308]: "The general principle ... is that a market solution considers profit at the appropriate margin, while social welfare takes into account the consumer's surplus".

[29] Setting $\alpha = 1$ with $k = 0$ results in a loss of $\mathcal{C}_n$ for any work such that no work will be created if $\mathcal{C}_1 > 0$. This is the case Landes and Posner have in mind when they talk about no works being created if marginal costs of copiers are below marginal costs of creators and all copies are homogenous (cf. Landes/Posner [1989:fn 15]).

[30] Thereby, we ease the analysis by eliminating a problem that Landes/Posner [1989] do not even consider: welfare per work may depend on the number of existing works, which in our model is captured by the dependence $v(N)$.

[31] Only for these values of k the direct and the indirect effect may work in the opposite direction. For $k > \underline{k}$ welfare per work decreases with an increasing k directly as well as indirectly, if the number of works is increasing with k and the valuation of existing works decreases with an additional work.

[32] For a proof of both propositions see the appendix.

[33] This argument can be found in Novos/Waldmann [1984,1987].

[34] $\mathcal{C}(\cdot)$ thus, replaces the sum $\sum_{n=1}^{\eta(k(\mathcal{P}))} \mathcal{C}_n$.

[35] This strategy has been recommended by an anonymous author, cited from the introduction by Machlup in Prosi [1971]; own translation.

[36] Sheldon vs. Metro-Goldwyn Pictures, cited from Landes/Posner [1989:fn 30]).

[37] Of course, also the question of who will have to pay for the enforcement of intellectual property rights depends on the way the copyright is implemented. Even without taking into consideration distributional issues, the total cost of operating the system as well as its effectiveness may depend on who has to pay. However, an analysis of how the implementation of copyrights affects, for example, the incentives of original producers to bring cases of copyright infringement before a court is beyond the scope of this paper.

[38] Koboldt/Schmidtchen [1991] (with reference to further literature) give an overview of possible mechanisms that may help to solve the basic problem of information production and dissemination. Here again, one has to take into account the interdependencies to get an impression of how, e.g., the possibility of price discrimination between individual and institutional demanders of journals affects the profits of producers, and consumer surplus.

[39] Cited from Jehoram [1993:117].

References

Besen, S. and Kirby, S.N. (1989): Private Copying, Appropriability and Optimal Copying Royalties, 32 Journal of Law and Economics, 255 ff.

Besen, S. and Raskind, L.J. (1991): An Introduction to the Law and Economics of Intellectual Property, 5 Journal of Economic Perspectives, 3 ff.

Breyer, S. (1970): The Uneasy Case for Copyright: A Study of Copyright in Books, Photocopies, and Computer Programs, 84 Harvard Law Review, 281 ff.

Cheung, S.N.S. (1986): Property Rights and Invention, 8 Research in Law and Economics, 5 ff.

Cooter, R. and Ulen, T. (1988): Law and Economics, Glenview and London.

Dixit, A.K and Stiglitz, J.E. (1977): Monopolistic Competition and Optimum Product Diversity, 67 American Economic Review, 297 ff.

Hurt, R.R. and Schuchmann, R.M. (1966): The Economic Rationale of Copyright, 56 American Economic Association Papers and Proceedings, 421 ff.

Jehoram, H.C. (1993): Urheberrecht: Eine Sache des Rechts oder der Opportunität?, in: E. Wadle (ed.): Historische Studien zum Urheberrecht in Europa, Berlin, Duncker und Humblot, 15 ff.

Kindermann, M. (1987): Technik und Urheberrecht – Wechselwirkungen und gegenseitige Abhängigkeiten, Zeitschrift für Urheber- und Medienrecht/Film und Recht 4/1987, 219ff.

Klippel, D. (1993): Die Idee des geistigen Eigentums in Naturrecht und Rechtsphilosophie des 19. Jahrhunderts, in: E. Wadle (ed.): Historische Studien zum Urheberrecht in Europa, Berlin, Duncker und Humblot, 121 ff.

Koboldt, C., Leder, M. and Schmidtchen, D. (1992): Ökonomische Analyse des Rechts, WiSt 7/1992, 334 ff.

Koboldt, C. and Schmidtchen, D. (1991): Copyrights – A und O in Literatur und Musik?, ORDO Bd. 42, 295 ff.

Landes, W. and Posner, R. (1989): An Economic Analysis of Copyright Law, 18 Journal of Legal Studies, 325 ff.

Liebowitz, S. (1986): Copyright Law, Photocopying and Price Discrimination, 8 Research in Law and Economics, 181 ff.

Menell, P.S. (1989): An Analysis of Copyright Protection for Application Programs, 41 Stanford Law Review, 1044 ff.

Novos, I.E. and Waldmann, M. (1984): The Effects of Increased Copyright Protection: An Analytic Approach, 92 Journal of Political Economy, 236 ff.

Novos, I.E. and Waldmann, M. (1987): The Emergence of Copying Technologies: What Have We Learned?, 5 Contemporary Policy Issues, 34 ff.

O'Hare, M. (1980): A Malthusian Nightmare for the Composer and His Audience, in: Hendon, W.S., Shannahan, J.L and MacDonald, A.J. (eds.): Economic Policy for the Arts, Cambridge, 114 ff.

O'Hare, M. (1982): Copyright and the Protection of Economic Rights, 6 Journal of Cultural Economics, 33 ff.

O'Hare, M. (1985): Why is Monopoly Efficient?, 4 Journal of Policy Analysis and Management 407 ff.

Peacock, A. (1979): Public Policy and Copyright in Music: An Economic Analysis, in: A. Peacock, The Economic Analysis of Government, Oxford, 137 ff.

Pethig, R. (1988): Copyright and Copying Costs: A New Price-Theoretic Approach, 144 Journal of Institutional and Theoretical Economics, 462 ff.

Plant, A. (1934): The Economic Aspects of Copyright in Books, 1 Economica (new series), 167 ff.

Polinsky, A.M. (1983): An Introduction to Law and Economics, Boston and Toronto.

Priest, G. (1986): What Economists Can Tell Lawyers About Intellectual Property: Comment on Cheung, 8 Research in Law and Economics, 19 ff.

Prosi, G. (1971): Ökonomische Theorie des Buches, Düsseldorf.

Quaedvlieg, A. A. (1992): The Economic Analysis of Intellectual Property Law, in: W.F. Korthals Altes, E.J. Dommering, P.B. Hugenholtz, and J.J.C. Kabel (eds.): Information Law Towards the 21st Century, 379 ff.

Russell, R.R. and Wilkinson, M. (1979): Microeconomics - A Synthesis of Modern and Neoclassical Theory, New York, John Wiley & Sons.

Schmidtchen, D. and Koboldt, C. (1993): A Pacemaker that Stops Halfway: The Decompilation Rule in the EEC Directive on the Legal Protection of Computer Programs, 13 International Review of Law and Economics, 413 ff.

Tenschert, H.J. (1987): Ist der Sound urheberrechtlich schützbar?, Zeitschrift für Urheber- und Medienrecht/Film und Recht 12/1987, 612 ff.

Thurow, N. (1987): Rechtsschutz für den Urheber und Urheberrechtsnutzer, Zeitschrift für Urheber- und Medienrecht/Film und Recht 6/1987, 320 ff.

Tirole, J. (1988): The Theory of Industrial Organization, Cambridge and London.

Tyerman, B.W. (1971): The Economic Rationale for Copyright for Published Books: A Reply to Professor Breyer, 18 UCLA Law Review, 1100 ff.

Wadle, E. (1993): Privilegienschutz gegen den Nachdruck um 1800: Der Fall Artaria contra Götz, in: E. Wadle (ed.): Historische Studien zum Urheberrecht in Europa, Berlin, Duncker und Humblot, 33 ff.

von Weizsäcker, C.C. (1981): Rechte und Verhältnisse in der modernen Wirtschaftslehre, 34 Kyklos, 345 ff.