PRIVATE COPYING, REPRODUCTION COSTS,
AND THE SUPPLY OF INTELLECTUAL PROPERTY

Stanley M. Besen

December 1984

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PREFACE

Recent technological developments, including photocopying, personal computing, and videocassette recording, have reduced the costs incurred by users when they copy journal articles, computer programs, and pre-recorded television programs or films. Moreover, either because such copying is legal, or because illegal copying is difficult to detect and prevent, a substantial amount of copying presently occurs. Under such circumstances, the producers of intellectual property can be expected to adapt in a variety of ways. These include changing marketing strategies and adopting technologies that make copying more difficult. This Note analyzes another possible producer action in the face of copying: changing the price of the original. It examines how the price of originals will be likely to change when copying occurs and, in turn, how the change would affect the welfare of consumers and the profits of producers.

Critical to the analysis are the price that would be charged by the producer if there were no copying, the cost to the producer of making additional originals, and the cost to consumers of making copies. Depending upon the relationship among these factors, consumers may be made better or worse off as a result of copying, producer profits may rise or fall, and the price of originals may increase or decrease. In addition, consumers are affected differently depending upon whether they "share" originals with others. The effect of copying is, therefore, likely to differ with the type of material being copied.

This material is based upon work supported by the National Science Foundation under Grant no. IST-8216474. The findings may be useful to producers of intellectual property, users of such property, and government officials and legislators concerned with questions of copyright and intellectual property.
SUMMARY

Recent technological advances, such as the personal computer and the videocassette recorder, have substantially reduced the cost of private copying of intellectual property. This has resulted in claims by producers that widespread copying has caused them great economic harm and pleas that the losses incurred should be compensated by means of royalties on recording machines and media. This Note develops an analytic model of the behavior of a "publisher," who can be the producer of books and journals, computer software, pre-recorded videocassettes, or other forms of intellectual property, when a technology that permits private copying is introduced. The model, which focuses on changes in the price of originals in response to copying, is used to analyze the effect of private copying on the profits of producers and the welfare of consumers.

Among the conclusions of the analysis are:

1. The introduction of copying can increase producer profits. This occurs where the technology available for producing copies is more efficient than that available for producing originals.

2. The introduction of copying can reduce the welfare of consumers. This occurs where the technology available to copiers is less efficient than that available to producers, but not so inefficient as to discourage copying, consumers are unable to enter into enforceable agreements not to copy, and publishers find it profitable to raise the price of originals.

3. The introduction of an inefficient copying technology can benefit consumers if it causes publishers to reduce the price of originals to discourage copying.

4. Some consumers may benefit from inefficient copying, if other consumers do not engage in copying, and the price for originals must be the same for both groups.
5. Producers' profits may decline even when copying is efficient, if not all consumers engage in copying.

The results of the analysis suggest that estimates of the harm that results from private copying may be overstated, if they fail to take into account any increase in the price of originals that publishers make in response to copying, or may be understated, if publishers reduce their prices to encourage the purchase of originals. The analysis suggests that the effect of private copying will vary among types of intellectual property depending upon the relative costs of producing originals and copies.
ACKNOWLEDGMENTS

This Note has benefited greatly from an exceptionally thorough and careful review by Herman Quirmbach. At various stages in the development of the project, useful comments were received from David W. Grissmer, M. Susan Marquis, Sheila N. Kirby, and Peter H. Reuter, as well as from participants in seminars at the Massachusetts Institute of Technology, the Office of the Register of Copyrights, and Rice University.
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PRIVATE COPYING, REPRODUCTION COSTS, AND THE SUPPLY
OF INTELLECTUAL PROPERTY

Where private copying of intellectual property was once a laborious
undertaking, recent technological advances--exemplified by the personal
computer and the videocassette recorder--have made it commonplace.
Moreover, because private copying is not easily detected, making
copyright enforcement difficult, or because private copying is sometimes
held to be fair use, and thus not a copyright infringement, producers of
intellectual property usually cannot protect their rights through legal
actions against copiers.¹ This has led to claims that private copying
has caused large losses to producers. For example, an estimate prepared
for the Recording Industry Association of America indicates that sales
displaced by home taping of audio materials, records, and cassettes
amounted to more than $1 billion in 1982.² Many producers are now
seeking to have royalties placed on recording devices and recording
media to replace the revenues that are claimed to be lost as a result of
private copying. Four countries--Austria, the Federal Republic of
Germany, the Congo, and Hungary--have adopted royalty arrangements, and
others are considering similar measures.³

¹G. Davies, The Private Copying of Sound and Audio-Visual
Recordings, A Study Requested by the Commission of the European
Communities, 1983, at 2 observes that "Even where private copying is
against the law...normal methods of enforcement are not appropriate;
detection is extremely difficult and, moreover, efforts to detect
private copying would be undesirable since they would give rise to an
unacceptable invasion of privacy." The International Bureau of
Societies Administering the Rights of Mechanical Recording and
Reproduction (BIEM) and International Confederation of Societies of
Authors and Composers (ISAC), Copyright, July-August 1982 at 214
describes private copying as "uncontrolled and uncontrollable."
²Statement of Alan Greenspan Re S.31 before the Subcommittee on
Patents, Copyrights, and Trademarks, Senate Committee on the Judiciary,
October 25, 1983. There are, however, reasons to be skeptical of these
estimates.
³For a discussion of the efforts, see Unauthorized Reproduction for
Private Purposes of Sound and Audiovisual Recordings, Broadcasts, and
the Printed Word, prepared by the Secretariats of the United Nations
Educational, Scientific, and Cultural Organization and the World
This Note analyzes the behavior of producers of intellectual property when a technology that reduces the cost of private copying is introduced and copying cannot be enjoined. The objective is to determine the effect of private copying on the profits of producers and the welfare of consumers of such property. The focus is on the copying of materials that have initially been sold directly to consumers and thus is relevant to the copying of books and journals, computer software, and pre-recorded audio and videocassettes. Issues involved in off-air taping are not considered. Although no attempt is made here to measure the losses in profits, if any, that result from private copying, the approach taken provides a framework within which to make such estimates. It also indicates why previous estimates of harm may be in serious error. Finally, the analysis in this Note may be useful in establishing appropriate royalty fees, if such an arrangement is adopted.

BASIC CONCLUSIONS

There are a number of possible ways in which producers of intellectual property can adapt to widespread private copying. They may accelerate the marketing of their products, in order to make the acquisition of an original more convenient than copying. They may embody originals in technologies that make copying more difficult. They may change the price that they charge for originals, and it is this response to copying that is the subject of this Note. The Note

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Although the principal focus of this Note is on private copying, some of the analysis may be applicable to organized piracy, where many copies of an original are sold as if they were genuine, or to the rental of intellectual property, which is another way for users to share a single original. It should be observed, however, that piracy is generally illegal and that enforcement of the right to prohibit unauthorized reproduction is often feasible in the case of piracy; See G. Davies, op. cit., at 12-13.

*This is not to suggest that changing the price of originals is the best, or only, way that producers will adapt. Indeed, it is likely that producers will respond in many ways simultaneously to offset the effects of copying. The focus of this Note on the price of originals should, therefore, be viewed as only the first step in an extended analysis of the behavior of producers where private copying occurs.
analyzes the behavior of a "publisher" of intellectual property and its customers. The analysis contrasts the behavior of the publisher when there is no copying with that when customers can copy the originals that are sold. It identifies the effects of copying on the price of originals and the number of originals sold and, in turn, its effects on the welfare of consumers and the profits of publishers.

Among the conclusions of the analysis are:

1. The introduction of copying can increase publisher profits. This occurs where the technology available to consumers is more efficient than that available to publishers, and certain other conditions are met.

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The publisher can be the producer of computer software, or motion pictures, as well as printed material. It should be observed that this Note does not distinguish between the interests of authors and performers and those of publishers.

The model on which this analysis is based was developed originally in D. K. Benjamin and R. C. Kornendi, "The Interrelationship Between Markets for New and Used Durable Goods," 17 Journal of Law and Economics 281 (1974) and first applied to copyright issues in S. J. Liebowitz, The Impact of Reprography on the Copyright System, Ottawa, Consumer and Corporate Affairs Canada, 1981. I have also had the benefit of reading S. J. Liebowitz, "Property Rights and Durable Goods," mimeo, n.d., which takes a similar approach to the one employed here. A significant difference is, however, the emphasis in this Note on the cost of private copying, where Liebowitz tends to emphasize the question of whether originals and copies are good substitutes.

In the terminology employed in this Note, publishers produce originals and consumers make copies.

For at least some types of intellectual property, the same technology that permits copying may itself increase the demand for the publisher's product. Thus, Keon argues that "while consumers may be buying home taping equipment and blank tapes, they may also be spending more on pre-recorded material." J. Keon, Audio and Video Home Taping: Impact on Copyright Payments, Ottawa, Consumer and Corporate Affairs Canada, 1982, at 12. Although this point is correct, in assessing the impact of private copying it is appropriate to compare producer profits and consumer welfare not with what they were before the new technology was made available but with what they would have been if consumers were required to obtain the right to copy from producers. Thus, the fact that producer profits may have increased as a result of introducing the new technology is not, by itself, a sufficient basis for rejecting the need to impose royalties on copying.
2. The introduction of copying can reduce the welfare of consumers. This occurs where the technology available to consumers is less efficient than that available to publishers, but not so inefficient as to discourage copying, and agreements not to copy are unenforceable.

3. The introduction of an inefficient copying technology can benefit consumers if publishers lower their prices in order to encourage consumers to purchase originals instead of engaging in copying.

4. The welfare of some consumers may increase if they copy even when copying is less efficient than producing originals if other consumers do not engage in copying and the price of originals is the same to all consumers.

5. Publisher profits may decline even when copying is more efficient than producing originals if not all consumers engage in copying and the price of originals is the same to all consumers.

THE BASIC MODEL

The basic model employed in this Note involves a number of simplifying assumptions. These are:

a. From the point of view of all consumers, using an original or using a copy of the output of a publisher are perfect substitutes. That is, no consumer would be willing to pay more to use an original than to use a copy of the same intellectual property.

b. The demand curve for originals is downward sloping, which reflects the fact that the products of different publishers are imperfect substitutes.

c. The publisher's costs consist of the cost of producing the "first copy" plus a constant marginal cost for each original produced and the publisher cannot alter its production technology to make copying more difficult.\(^{12}\)

\(^{10}\)Some of these are relaxed in subsequent sections and others will be relaxed in future work.

\(^{11}\)According to S. V. Berg, "Increasing the Efficiency of the
d. The first copy costs have already been incurred.\textsuperscript{13}

e. The marginal cost of making a copy is constant and independent
of the number of copies made from each original.

f. If copying occurs, each original is copied the same number of
times and the number is fixed.\textsuperscript{14}

g. Publishers are unable to prevent copying through legal action
taken against copiers, either because they cannot detect the
existence of copying, or because copying is considered to be
fair use.

\textsuperscript{12}The final section of this Note considers how the results of the
analysis might change if the producer can, by incurring increased
production costs, limit the extent of copying.

\textsuperscript{13}The analysis in the basic model is, thus, concerned only with the
short-run. Some observations on the effect of copying in the long run
are contained in the last section of the Note.

\textsuperscript{14}In a later section, this assumption is relaxed to allow for some
originals to be copied while others are not. A more general analysis
would allow the size of the group that shares an original to be
endogenous. For any price being charged for originals, and for any
copying technology, if the cost of making and distributing additional
copies rises as the number of copies made from an original increases,
there will be an optimum size group, i.e., a group size where the cost
per member is minimized. The optimum size of the sharing group will be
larger the higher is the price of originals and the lower is the cost of
copying.
Suppose that private copying does not exist and that a technology is invented that permits copies to be made from each original. Because originals and copies are perfect substitutes, the price of using either will be the same. One can think of this as involving either (i) a set of users agreeing to purchase an original and to divide its price and the cost of copying equally among them or (ii) purchasers of originals competing to sell copies to other users. In (ii), the price of a copy would equal the price of an original plus the cost of making copies minus the revenues from the sale of the copies, which is the cost of using an original. If the price of a copy is less than this amount, some would-be purchasers of originals would buy copies and the effect would be to equalize the cost of using an original and the price of a copy. For similar reasons, the price of a copy cannot exceed the cost of using an original.  

The effect of introducing copying is to increase the demand for originals, either because their costs can be shared or copies can be sold, but the increase in demand will be less than proportional to the number of copies made. To be more precise, if without copying the demand for originals is \( P = a - bQ \), when \( n \) copies are made from each original and the cost of a copy is \( r \), the demand curve becomes \( P = (1 + n)a - ((1 + n)^2bQ) - nr \) for values of \( P > r \). The demand curve is

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15 In a recent article, I. E. Novos and M. Waldman, "The Effects of Increased Copyright Protection: An Analytic Approach," 92 Journal of Political Economy 236 (1984), an alternative assumption about the structure of demand is employed. In the Novos-Waldman model, all consumers value the good equally but have different reproduction costs. A consumer purchases an original if its price is less than his reproduction cost. Otherwise, he makes a copy and pays only the cost of copying. Implicitly, purchasers of originals make them freely available to copiers, where in the model presented in this Note copiers must purchase the right to copy and, therefore, may pay more than copying costs to use a good.

16 Transaction costs are implicitly either zero or included in reproduction costs.

17 See J. Hirshleifer, "Suppression of Inventions," 79 J. of Pol. Econ. 382 (1971). The significance of the assumption that the demand for originals fully reflects the value of the copies that can be made from them less the cost of reproduction should not be underestimated. The purchaser of an original will be unwilling to pay the value of the copies that will be made if he is unable to capture these amounts from other users.
unchanged below r since, at such prices, it is necessarily cheaper to purchase an original than to purchase a copy. Note that the rotation of the demand curve requires only the assumption that originals and copies are perfect substitutes.

The effect of private copying on the demand for originals is illustrated graphically in Fig. 1. The demand for originals in the absence of copying is shown as DD. If originals can be copied, the demand curve rotates both because, at some prices, the number of originals demanded is increased, since the price is divided among several users, and because the market is saturated at a smaller number of originals. The greater is the number of copies per original, the steeper is the new demand curve.

If private copying costs are positive, the demand for originals is reduced by the amount of these costs. That is, in determining the effect of copying on the demand for originals one must take into account not only the fact that the value of originals has increased, because their costs can be shared, but also that there are costs incurred in making copies. The new demand curve is shown as D1D1. Below r, the demand curve is, of course, unchanged.

If c is the producer's marginal cost, before copying the price charged for an original, P*, is \((a + c)/2\) and the quantity sold, Q*, is \((a - c)/2b\). If n copies are made per original the price of an original, P^n*, is \(((a + c)/2) + (n(a - r)/2)\) and the quantity sold, Q^n*, is \((a(1 + n) - c - nr)/2b(1 + n)^2\). Copying raises the price of originals, since a must exceed r. If c and r are both equal to zero the price of an original increases to \((1 + n)\) times the price in the absence of copying. In general, however, the price of an original rises by less

---

18 This includes transaction costs.
19 It is assumed throughout this Note that producers attempt to maximize profits. Although this is clearly plausible for commercial firms, it may be objected that nonprofit producers have other objectives. However, if, as seems likely, entry is relatively free, even nonprofit firms will be forced to set journal prices so as to maximize profits if they are to survive unless they receive substantial revenues from other sources, e.g., page charges.
20 If \(r > (a + c)/2\), copying does not occur because it is less expensive to purchase an original than to copy.
Fig. 1 — Demand for originals with and without copying
than that proportion, since \((a + c)\) exceeds \((a - r)\).

If there is copying, the cost of using an original is, of course, less than the price of an original since the price, and the associated copying costs, are shared among users. Under the assumption that using a copy is a perfect substitute for using an original, we can determine the cost of a "use" by dividing the price of an original and copying costs by \((1 + n)\). The result is

\[
(((a(1 + n) + c - nr)/2) + nr)/(1 + n) = ((a + c)/2) + ((r - c)n/2(1 + n)).
\]

Whether this is greater than or less than \((a + c)/2\), the price of an original, if there is no copying, depends entirely on the relationship between \(c\) and \(r\), the respective costs of producing originals and copies. If \(c > r\), so that producing copies is less expensive than producing originals, the cost of a use is reduced when copying is introduced.\(^{22}\)

If \(c < r\), copying raises the price of a use. Where \(c = r\), the cost of a use equals the price that would have been charged for an original had there been no copying, \((a + c)/2\). Thus, whether consumers benefit or lose when copying is introduced depends on whether or not copying is

---

\(^{21}\)Keon, *op. cit.*, at 15 argues that "the introduction of home taping equipment and the subsequent increased incidence of home taping will curtail record companies' ability to increase price...in the face of increased competition from this source. Therefore, while home taping may cause lost sales, it also prevents recording companies from compensating for any lost sales by raising the prices of pre-recorded tapes and records." However, so long as the number of copies made from each original is limited, producers will be able to raise the prices of originals when copying occurs. In the model employed here, the number of copies is limited by assumption. In a more general analysis, the limitation will be produced by rising marginal costs as the size of the sharing group is expanded. See J. M. Buchanan, "An Economic Theory of Clubs," 32 *Economica* 1 (1965). In the more general case, group size will be finite only if these costs rise more rapidly than the associated increase in the price of originals. But, since the cost of copying affects the demand for originals, this condition will almost certainly be met.

\(^{22}\)If the same copying "technology" is available to the publisher as to consumers, this situation cannot occur. However, some costs, e.g., distribution, may be lower for consumers, yet the publisher cannot adopt the lower cost technology.
more efficient than producing originals, since that determines whether the cost of a use falls or rises. Perhaps surprisingly, consumers are worse off when copying is introduced if copying is inefficient.\footnote{There are two other ways to measure the effect of copying that are equivalent to examining the cost of a use. One is to compare the number of originals sold without copying to the number of originals plus copies after copying is introduced. If \( c > r \), i.e., if copying is efficient, the latter exceeds the former. Alternatively, one can measure consumer surplus directly. If the cost of a use declines, the number of originals plus copies will exceed the number of originals that would have been purchased if there were no copying and consumer surplus will increase.}

Without copying, publisher profits\footnote{This Note does not discuss in detail the effect of introducing a low-cost reproduction technology on the number of "first copies" produced. Thus, when the term profits is used we mean the difference between total revenue and variable cost. Some remarks on long-run effects appear in the final section.} are

\[
\frac{(a - c)(a - c)}{4b}
\]

while after copying they are

\[
\frac{(a(1 + n) - c - nr)(a(1 + n) - c - nr)}{4b(1 + n)(1 + n)} = \frac{(a - c + X)^2}{4b}
\]

where \( X = \frac{n(c - r)}{(1 + n)} \).

As in the case of consumer welfare, the effect of copying on publisher profits depends entirely on the relationship between \( r \) and \( c \). If \( r > c \), i.e., if copying is inefficient, copying reduces producer profits. However, if \( r < c \), profits are increased when copying is introduced. This occurs because the publisher is able to substitute efficient private copying for his own production of originals.\footnote{Hirshleifer, \textit{op. cit.}, obtains this result when he analyzes whether a monopolist will increase the durability of his product if he can do so costlessly.}

Where the cost of copying is less than the cost of producing originals, total welfare and the welfare of both consumers and publishers are increased by the introduction of copying. Because copying is more efficient than producing originals, there is a gain even
if the number of uses remains unchanged, since fewer resources are employed. Moreover, there will generally be an increase in the number of users as their price decreases, leading to further increases in consumer welfare and publisher profits. Finally, larger publisher profits are likely to lead to an increase in the number of first copies that are produced. Here, both publisher and consumers are made better off as a result of copying.

Where reproduction cost exceeds the cost of originals, output is produced at more than minimum cost because, by assumption, costs are lower for originals than for copies. Thus, even if there were no effect on total output, so that the number of originals plus copies just equals the number of originals that were made before copying was possible, a welfare loss would result because producing originals is more efficient than making copies.

Second, the number of originals plus copies is smaller than total output was originally unless demand is completely inelastic. In general, the higher price of a use reduces the number of uses. There is thus a deadweight loss that results from the failure of output to be supplied that is valued at more than its cost of production.27

In this case, it may be in the interest of both consumers and publishers to ban copying. Since the cost of copying is higher than the cost of originals, but lower than the price of originals when there is no copying, consumers will copy even though it would be more efficient to have additional originals produced by the publisher.28 But, if copying is permitted, the resulting increase in the price of originals reduces consumer surplus below the level obtained when copying is banned. Here, overall welfare, as well as the welfare of consumers, may be increased by banning copying.

26We are assuming that the price of an original exceeds the cost of reproduction, so that copying takes place.
27This is in addition to any deadweight loss that existed before the introduction of copying.
28A more general model would permit n to vary depending on the relationship between r and c. If the assumption that originals and copies are perfect substitutes is retained, one way to limit n is to assume that r is an increasing function of n. But, in such a model, copying will occur to the point where r equals the price of an original, so that inefficient copying may occur.
Finally, if the industry was initially in long run (monopolistically competitive) equilibrium, with all firms earning normal profits, copying reduces publisher profits and thus the number of first copies that are produced.

It is important to observe that copying will continue to occur even where it makes consumers worse off. Since, by assumption, copying cannot be detected, consumers cannot enter into enforceable agreements not to copy. For the same reason, publishers must assume that copying will occur, and, thus, they will raise the price of originals. If agreements not to copy were enforceable, and if copying is inefficient, consumers would enter into such agreements, and the price of originals would fall. Publisher profits would, as a result, increase, and consumers would benefit from the decline in the cost of a use.

To summarize the case where there are costs of reproduction and a fixed number of copies per original, and the price of originals is raised when a copying technology is introduced: (1) There will be no incentive to copy, and therefore no need to forbid it, if the cost of copying exceeds the price that maximizes producer profits in the absence of copying; (2) if the publisher's marginal cost of producing originals is greater than the marginal cost of copying, it is profitable for the producer to permit copying to take place and consumers are also made better off by the introduction of copying; and (3) if the cost of copying is less than the price that maximizes producer profit without copying, but exceeds the cost of reproduction, and if producers raise the price of originals when the private copying is introduced, copying will occur and both producer profits and consumer surplus will fall. In the last case, consumers may be better off if copying were banned, yet each consumer has an incentive to copy.

Suppose, of course, it is possible that it is no longer profitable to produce the "first copy." One superficially puzzling aspect of this result is that it seems to conflict with that of Benjamin and Kornndi [B-K]. They argue that, under certain circumstances, sellers may be better off, i.e., make larger profits, when copying is banned even though there are costs to making additional "originals." However, they implicitly assume that private reproduction is costless. The key to understanding the difference between the B-K result and the one obtained here is to observe that in their competitive model the price of an original that cannot be copied may be greater than that of an original
SOME ILLUSTRATIVE EXAMPLES

To illustrate the effect of copying on the welfare of consumers and the profits of publishers consider the following examples:

Demand curve without copying: \( P = a - bQ \)

Demand curve with copying, one copy per original: \( P = 2a - 4bQ - r \)

Marginal cost of reproduction: \( c \)

Suppose that \( a = 10, b = 1, \) and \( c = 1, \) then the price of originals without copying is 5.5, 4.5 originals are sold, "profits" (ignoring "first copy" costs) are 20.25, and consumer surplus is 10.13, as shown in Table 1. If copying is permitted and \( r = 3, \) the profit maximizing price for an original rises to 9, two originals are sold, the number of uses, originals plus copies, falls to 4, profits decline to 16, and consumer surplus is reduced to 8. Because copying is inefficient, i.e., because \( r > c, \) both consumer surplus and producer profits are reduced by the introduction of copying.

that can be. If the marginal cost of originals is increasing and if it intersects the "copying" demand curve at a lower price than its intersection with the "no copying" demand curve the competitive firms in B-K obtain larger quasi-rents when copying is banned. By contrast, under monopoly, if there are no costs of private reproduction, the price of originals where there is no copying must be lower than where there is copying so that quasi-rents are also higher. Where the demand curves are those described in the example above and there are no costs of reproduction, i.e., \( r = 0, \) the price charged for originals when there is no copying, \( P^* \), is \((a + c)/2 \) and the price charged when there is copying, \( P^{**} \), is \( a + c/2 \). Since profits are higher when there is copying, the sum of monopoly profits and quasi-rents earned by the monopolist must also be greater. This occurs with constant marginal production cost and, a fortiori, when marginal cost is increasing. Moreover, the proposition that copying must raise the price of originals under monopoly does not require that \( r = 0: \) (1) \( P^* < a \) since the price cannot exceed the intercept of the demand curve; (2) \( r < P^* \) or there will be no copying; therefore (3) \( r < a. \) With linear demand curves, \( P^* = (a + c)/2 \) and \( P^{**} = (an + a + c - nr)/2. \) Subtracting \((a + c)/2\) from both and dividing the result by \( n \) leaves \( P^* = 0 \) and \( P^{**} = (a - r). \) But, from (3), \( a > r \) so that \( P^{**} > P^*. \)
Table 1
THE EFFECTS OF COPYING WHERE ALL ORIGINALS ARE COPIED

<table>
<thead>
<tr>
<th></th>
<th>Price of Originals</th>
<th>Number of Originals Sold</th>
<th>Number of Uses</th>
<th>Consumer Surplus</th>
<th>Publisher &quot;Profits&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>No copying</td>
<td>5.5</td>
<td>4.5</td>
<td>4.5</td>
<td>10.13</td>
<td>20.25</td>
</tr>
<tr>
<td>Copying (r = 3)</td>
<td>9.0</td>
<td>2.0</td>
<td>4.0</td>
<td>8.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Copying (r = .5)</td>
<td>10.25</td>
<td>2.31</td>
<td>4.62</td>
<td>10.70</td>
<td>21.39</td>
</tr>
</tbody>
</table>

If \( r = .5 \), however, so that \( r < c \), both publisher and consumers are made better off by copying. With copying, the price of originals rises to 10.25, 2.31 originals are sold, the number of uses increases to 4.62, profits rise to 21.39, and consumer surplus increases to 10.70. Since copying is efficient, both consumers and the publisher are better off.

LIMIT PRICING

The previous analysis ignored the possibility that the publisher can set a "limit price" for originals to discourage copying. Since copies will be made only if the price of an original exceeds the cost of a copy, by reducing the price of originals to just below the cost of copying, \( r \), the publisher can discourage copying.\(^3\) The quantity sold under the limit pricing strategy, \( Q_L \), is equal to \( (a - r)/b \). Under certain circumstances, such a strategy will produce greater profits than if the publisher accepted copying and raised its prices. A necessary condition is that the marginal cost of reproduction exceeds that of making an original, but that is not sufficient.\(^4\) In general, the limit pricing strategy is more likely to be profitable the larger is the gap

\(^3\)Since \( P^* = (a + c)/2 \), we need consider only cases in which \( r < (a + c)/2 \).

\(^4\)The condition is that \( (r - c)(a - r)(1 + n)^2 > (a(1 + n) - c - nr)^2/4 \).
between the marginal costs of originals and copies, that is, the greater is $r$. Indeed, in the example presented above, if $r = 5$, profits fall only to 20 when a limit price is established, while they decline to 12.25 if the price of originals is increased.

Several things should be noted about the equilibrium under limit pricing. First, production costs are minimized, since it is inefficient for copies to be made when copying costs exceed the cost of producing originals. Second, consumer surplus is higher than before copying was possible, since originals now sell at the lower limit price. Third, profits fall because publishers are forced to charge less than the profit-maximizing price. Finally, the sum of publisher profits and consumer surplus increases because limit pricing reduces the deadweight loss that results from monopoly pricing.\(^{12}\)

Where introducing copying causes the price of originals to rise, both publisher profits and consumer surplus decline if copying costs exceed the cost of producing originals, since both producers and users share in the loss created by the use of an inefficient production technology. However, where introducing copying causes publishers to adopt a limit pricing strategy, although publishers are worse off than if there were no copying, consumers are better off.\(^{33}\) Moreover, total welfare, profits plus consumers surplus, rises even where reproduction costs are greater than the costs of producing originals. Of course, such an outcome requires that profits be greater when the limit pricing strategy is pursued than where the publisher accepts the existence of copying.\(^{34}\)

\(^{12}\)Again, recall that this analysis ignores the effect of lower producer profits on the supply of "first copies."

\(^{33}\)S. Breyer, "The Uneasy Case for Copyright: A Study of Copyright in Books, Photocopies and Computer Programs," 84 Harvard L. Rev. 281 (1970), argues that "as long as prices for low volume texts and tradebooks do not rise far above the costs of the original publisher, it seems unlikely that a [copying] competitor will enter the market" (fn 85 at 301) and that "In many cases photocopying will not seriously interfere with journal revenues...because publishers can make up for a decline in the number of subscriptions by raising their prices" (at 335). The first of these responses to copying is, of course, the limit pricing approach, while the second is the strategy discussed in the previous section. The two types of responses are, thus, alternatives available to the publisher, not strategies that can be adopted simultaneously. Moreover, profits will decline whichever strategy is adopted unless copying costs are lower than those of the publisher.

\(^{34}\)An interesting example of limit pricing concerns the recent
CONSUMER SURPLUS AND THE COST OF COPYING

To illustrate the effect of copying on the welfare of consumers, Fig. 2 plots the change in consumer surplus resulting from copying for various values of $r$, the cost of copying. Based on the previous analysis, there are four regions of interest. For $r > (a + c)/2$, the price of originals without copying, there is no change in consumer surplus, since no copying occurs.

For $r < (a + c)/2$, but above the value of $r$ where the profit maximizing strategy of the publisher is to raise the price of originals, consumer welfare rises, because the limit pricing strategy causes the price of originals to fall. The size of the gain to consumers is smaller, the closer is $r$ to $(a + c)/2$ and it reaches a maximum, for the limit pricing strategy, at the critical value of $r$, $r^*$, where the strategy is abandoned.\(^1\)

For values of $r$ below $r^*$, but above the cost of originals, $c$, consumer surplus is reduced by copying. Since copying is inefficient, and the price of originals rises, the cost of a use increases. The magnitude of the loss is smaller the lower is $r$, and there is no change in surplus when $r = c$.

For $r < c$, consumer surplus is increased by copying. Although the price of originals rises, because copying is efficient the cost of a use declines. The increase in the surplus is larger the smaller is $r$, and reaches a maximum at $r = 0$.

CONGRUENCE OF PUBLISHER AND CONSUMER INTERESTS

It is common to regard the introduction of copying as producing benefits to consumers and causing harm to publishers. The previous analysis should make it clear that such a conclusion is far too simple. Indeed, what the analysis demonstrates is that the interests of consumers and those of publishers may be congruent, rather than divergent, with respect to the effects of copying. They may both

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\(^1\)The critical value is equal to $c + (p^{**} - c)(Q^{**}/QL)$.
Fig. 2 — Relationship between consumer surplus and copying costs
benefit, or they may both be harmed, when copying is introduced. Table 2 provides a convenient way to compare the effects of copying on the two groups within the basic model.

Table 2 makes clear that publisher and consumer interests diverge in this model only when the limit pricing strategy is adopted. In such cases, in the short run, publisher profits decline while consumer surplus rises. However, where the price of originals is increased when copying is introduced, the interests of publishers and consumers are congruent. If copying is efficient, both benefit from copying. If copying is inefficient, both are worse off.

THE MEASUREMENT OF HARM FROM COPYING

In attempting to justify government intervention to alleviate the losses that they claim are caused by private copying, a number of groups of copyright owners have attempted to measure these losses. For example, as previously noted, an estimate prepared for the Recording Industry Association of America is that lost sales of records and audio cassettes amounted to more than $1 billion in 1982. Davies reports

Table 2

CONGRUENCE OF PRODUCER AND CONSUMER INTERESTS

<table>
<thead>
<tr>
<th></th>
<th>Effect on Publishers</th>
<th>Effect on Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>No copying</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>[r &gt; (a + c)/2]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limit pricing</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Inefficient copying</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[r &gt; c]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficient copying</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>[r &lt; c]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

the results of a 1979 United Kingdom survey that indicate that lost sales of records and audio tapes amounted to over $600 million, which was the equivalent of 70 percent of the value of retail sales in that year. Keon reports that a study of the impact of home audio taping in the British market performed for the British Phonographic Industry Copyright Association concluded that a conservative estimate of lost sales in 1977 was over $100 million.

These studies have been criticized on a number of grounds. For example, Keon notes that lost profits will be smaller than lost sales because, if fewer originals are sold as a result of copying, production costs are also reduced. Moreover, he observes that the methods employed to estimate the number of copies that replace the purchase of originals are often questionable. Estimates of the amount of copying that is occurring do not appear to be reliable. From the point of view of the present Note, however, the most glaring shortcoming involves the assumption, implicit in all of them, that the price of originals is unaffected by the existence of copying.

In most of these studies, after an estimate is made of the number of copies made in lieu of purchasing originals, the estimate is multiplied by the existing price of originals to determine lost sales. However, the analysis in this Note suggests that the existence of copying is likely to change the price of originals. Where the price of originals is increased, the methods employed to estimate harm that do not take this into account overstate the losses to producers. Where

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38 Actual estimates were between $90 and $210 million, depending on the method used to estimate the number of copies that represent forgone purchases of originals.
39 Among the estimates of computer software copying are that (i) MicroPro is paid for "about one out of five copies of WordStar in the U.S., and about one out of ten in Europe." Regulation, November/December 1983, at 13; (ii) for every copy of a VisiCorp product sold there is at least one pirate copy. Idem.; and (iii) illegal copies account for from two to nine times the number of programs sold legally." Washington Post, Washington Business, March 19, 1984 at 15. The sources of these estimates are not provided.
40 Where the number of copies per original is endogenous, one effect of raising the price of originals is to increase the number of copies
limit pricing is employed, these approaches understate the harm that is done.\textsuperscript{41}

These methods employed to estimate harm may also overstate the increase in producer revenues that results from the imposition of a royalty on recording media. Because the increase in the cost of copying that results from the imposition of the royalty will reduce the demand for originals, revenues from the sale of originals will be reduced. This decline must be offset against the royalties that are collected.\textsuperscript{42}

**VARIABLE NUMBER OF COPIES PER ORIGINAL**

To this point we have assumed that, if copying occurs, the same number of copies is made from each original. A simple way to analyze the effect of allowing the number of copies per original to vary is to assume that there are two groups of consumers. For one group, copying is uneconomic, because \( r \) is greater than the price of originals.\textsuperscript{43} At the same time, there is another group whose sharing behavior is as characterized above, i.e., there is a fixed number of copies per original and \( r \) is less than the price of originals.\textsuperscript{44} Further, it is per original. In such cases, although producers may mitigate some of the effects of copying by raising the price of originals, this will be partially offset by the decrease in the number of originals that are sold. As a result, estimating the harm from copying becomes even more complex.

\textsuperscript{41}In the one study in which recognition is taken of the fact that copying may affect the price of originals, Greenspan, *op. cit.* at 7-8, argues that copying has depressed prices on record sales by at least 5 percent. This estimate appears to be based entirely on a comparison of changes in record prices and movements in the general price level, attributing the difference to private copying. However, as the model developed in this Note makes clear, estimating the effect of copying on the price of originals requires information about the amount of copying, the cost of producing originals, and the cost of copying, none of which is taken into account in deriving Greenspan’s estimate.

\textsuperscript{42}Even where the number of copies per original is endogenous, where the cost of copying increases by the amount of the royalty, the optimum size of the sharing group is unaffected. Nevertheless, the royalty reduces the demand for originals since it increases the cost of a use. Where the imposition of a royalty affects the number of copies per original, it is even more difficult to determine the effect of the royalty on producer revenues. This situation will be examined in later work.

\textsuperscript{43}One can think of this group as being at remote locations where there are few, if any, other users with whom they can "share."

\textsuperscript{44}It is possible, of course, for \( r > c \) for this group.
assumed that the producer cannot charge different prices for originals to the two groups of users.  

Assume that, in the absence of copying the demand curves for both potential copiers and those who will not copy are both \( P = a - bQ \) so that their horizontal sum is \( P = a - (b/2)Q \). With copying, above \( a \) the demand curve for originals is, as before, \( P = a(1 + n) - (1 + n)^2bQ - nr \). Below \( a \), but above \( r \), it is \( P = a + ((an - nr)/(1 + (1 + n)^2)) - ((b(1 + n)^2)/(1 + (1 + n)^2))Q \). Below \( r \) it is \( P = a - (b/2)Q \). The demand curve is shown in Fig. 3.  

There are two possible types of equilibria. In the first, the price of originals is so high that purchases are made only by members of the group that engages in copying. Here, copiers are better off if \( r < c \), for the same reason as above, and non-copiers are necessarily worse off.  

In the second type of equilibrium, some non-copiers continue to purchase originals. However, the price of originals becomes \( (a + c)/2 + (n(a - r))/(2(1 + (1 + n)^2)) \). Since this must be higher than the price where there is no copying, those users who are unable to share are necessarily made worse off by the introduction of copying. However, copiers may be better off even if \( r > c \). Indeed, if \( n \) is very large, i.e., if there is a large number of copies per original, the price of originals will be unchanged when copying occurs. If this occurs, copiers will be better off.

---

45This occurs either because producers cannot distinguish among members of two groups or because of a legal barrier to price discrimination. The "first sale" doctrine, which prevents motion picture producers from charging different prices for pre-recorded videocassettes to owners of video rental stores than to "final" consumers, is an example of the latter. It is also assumed implicitly that consumers cannot move between the two groups.

46Since the demand curve is convex, the discontinuity in marginal revenue creates the possibility that marginal cost will intersect marginal revenue twice.

47Note that non-copiers are worse off since they choose not to purchase any originals at the higher price, even if \( r < c \) for copiers.

48It does not seem likely that this result will generalize to groups of any size, since we know that if there are only sharers they are made better off when copying is introduced only if \( r < c \). Recall that where all originals were shared equally we had only to consider in detail the case where \( r > c \), since if \( r < c \) for all groups both producers and consumers benefit from copying if the value of all subsequent users can be captured in the sale of originals. Here, even if \( r < c \) for copiers, by assumption \( r > c \) for the non-copiers.
Fig. 3 – Demand for originals when only some originals are copied
It should also be noted that producer profits are necessarily reduced by the introduction of copying where \( r > c \). This can be shown by observing that, in the absence of copying, the price for each of the groups was the same as in the no copying case analyzed above, \( (a + c)/2 \). We know, however, that in the present case the price charged to each of the groups rises when copying is introduced. But the demand curve for the group not engaged in copying has not changed so the profit-maximizing price for that group is unchanged. Raising price thus reduces profits from serving that group. And, from the previous analysis, we know that profits from the copying group fall where \( r > c \).\(^4\)

Next, it should be observed that even where producer profits and the welfare of non-copiers is reduced, total welfare may actually increase, since copiers may be better off. Moreover, in the presence of non-copiers, copiers may be better off even if \( r > c \) since the same price is charged to both groups.\(^5\) Where the profit maximizing price does not change, copiers are better off if \( r < P \).\(^6\) Total welfare is more likely to increase the smaller is \( r \).

Next, we can observe that where \( r < c \), producer profits may increase when copying is introduced. However, this condition does not guarantee an increase in profits as it did above because here there are non-copiers for whom, by definition, \( r > c \).\(^7\)

\(^4\)Where \( r < c \) for the copying group, the effect on profits is more complex, since profits from serving this group rise while profits from serving the other group decline.

\(^5\)This assumes that it is more profitable to continue to serve non-copiers than to raise the price of originals sufficiently to exclude them.

\(^6\)This result is an artifact of the assumptions that the two groups are of equal size and have the same demand for originals.

\(^7\)This model can also be used to analyze the effect of "organized" copying. Suppose that some originals are acquired by "pirates" who distribute \((1 + n)\) units for each original they purchase. Assume, further, that the producer cannot distinguish between pirates and other purchasers nor can he detect sales made by the pirates. In this case, the price paid by purchasers of "true" originals will exceed the price paid for pirated copies, but all consumers may be worse off than if piracy were eliminated. Similarly, the model can be applied to the simultaneous sale and rental of products like videocassettes. In the presence of the "first sale doctrine" the same price will be charged both for cassettes that are purchased by final consumers and those
Finally, we note that non-copyers can be made better off when copying is introduced if and only if limit pricing maximizes producer profits. Here, of course, although profits decline, both copiers and non-copyers are better off. This outcome is more likely the higher is r.

SOME ILLUSTRATIVE EXAMPLES

To illustrate the workings of the models developed to this point, assume that the demand curves for non-copyers and potential copiers are both \( P = 10 - Q \) and that \( n = 5 \). Before copying, the situation is illustrated in the first column of Table 3.

The cases in Table 3 are designed to illustrate a range of possible outcomes when some originals are copied and others are not. Consider the case in which \( c = 2 \) and \( r = 0 \). Copying is clearly efficient, and copiers benefit from its existence. However, both publishers and non-copyers lose when copying is introduced. Profits decline because of the inability of publishers to price discriminate, i.e., to charge higher prices for those originals that will be copied. Unlike the case in which all originals are copied to the same extent, and where publishers benefited from efficient copying, here they do not, because only some of their customers copy. Non-copyers lose because they must pay a higher price for originals but have no one with whom to share the cost. In this example, the increase in the benefits to copiers is so great that the total surplus, 67.49, is greater than the surplus without copying.

If we turn to the case in which \( c = 2 \) and \( r = 3 \), so that copying is inefficient, i.e., \( r > c \), another interesting result emerges. Here, as before, publisher profits decline and non-copyers are harmed because the introduction of copying leads to a rise in the price of originals. However, copiers are better off even though copying is inefficient. The reason is that the increase in the price of originals that results when purchased for the purpose of rentals. The existence of the rental market may, for the reasons discussed here, make purchasers worse off and even renters may benefit from the elimination of the "doctrine." Another possibility is that the existence of the rental market may benefit renters while harming other consumers.
Table 3
THE EFFECTS OF COPYING WHERE ONLY SOME ORIGINALS ARE COPIED

\[ D_1, D_{II} \quad P = 10 - Q \]

<table>
<thead>
<tr>
<th></th>
<th>No Copying</th>
<th>( n = 5 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>c = 2, r = 0</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>32</td>
<td>22.47</td>
</tr>
<tr>
<td>Non-Copier surplus</td>
<td>8</td>
<td>5.53</td>
</tr>
<tr>
<td>Copier surplus</td>
<td>8</td>
<td>39.49</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>48</td>
<td>67.49</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>No Copying</th>
<th>( n = 5 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>c = 2, r = 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>32</td>
<td>20.56</td>
</tr>
<tr>
<td>Non-Copier surplus</td>
<td>8</td>
<td>6.22</td>
</tr>
<tr>
<td>Copier surplus</td>
<td>8</td>
<td>20.62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>48</td>
<td>47.40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>No Copying</th>
<th>( n = 5 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>c = 2, r = 4</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>32</td>
<td>24</td>
</tr>
<tr>
<td>Non-Copier surplus</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Copier surplus</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>48</td>
<td>60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>No Copying</th>
<th>( n = 5 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>c = 9, r = 0</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>.50</td>
<td>18.06</td>
</tr>
<tr>
<td>Non-Copier surplus</td>
<td>.25</td>
<td>---</td>
</tr>
<tr>
<td>Copier surplus</td>
<td>.25</td>
<td>9.03</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.00</td>
<td>27.09</td>
</tr>
</tbody>
</table>
copying is introduced is limited by the presence of non-copiers, so that the price of a use to copiers actually falls.\textsuperscript{53}

Next, consider the case where \( c = 2 \) and \( r = 4 \). Here, profit maximization involves setting a limit price. In this case, profits fall to 24, below their value without copying, but above the value of 19.95 that results if the price of originals is increased. Here, non-copiers as well as copiers are made better off by the introduction of an inefficient copying technology.

Finally, where \( c = 9 \) and \( r = 0 \) and copying is introduced, profits increase from .50 to 18.06, the surplus of copiers increases, and non-copiers are excluded from the market.\textsuperscript{64} Although total welfare increases, non-copiers are made worse off even though copying is efficient.

\textbf{PARTIAL COPYING}

To this point we have assumed that copiers desire to purchase an entire original. Although this may be an appropriate assumption for intellectual property such as computer programs, for property such as scientific and professional journals it seems less apt. To explore the effect of the existence of "partial" copying, we consider a simple model.

We assume that there exists one class of buyers who want complete "editions" and another who desire to use only selected portions of originals but who would, in the absence of the ability to copy, consider the purchase of an entire edition and that there is a single partial copier for each purchaser of an original.\textsuperscript{55} Moreover, we assume that

\textsuperscript{53}It does not pay the publisher to serve only copiers, since profits from serving this group were only 16 when there was no copying, and they will necessarily be lower where copying is inefficient.

\textsuperscript{54}Only by setting the price of originals below 10 will non-copiers continue to purchase, but this results in smaller profits than if only copiers are served.

\textsuperscript{55}Because purchasers of originals and copies do not regard the two as equivalent it is necessary here, as it was not in the perfect substitutes case, to separate consumers into groups at the start of the analysis.
the demand of the would-be copiers for originals is the same as that of purchasers of originals reduced in proportion to the amount of copying that will be done. In particular, if the demand by the purchasers of originals is \( P = a - bQ \), the demand for originals by those who wish only to copy \( 1/q \) of an original is \( P = (a/q) - (b/q)Q \). In the absence of copying, the market demand curve for prices above \( a/q \) is \( P = a - bQ \) while for prices at or below \( a/q \) it is \( P = (a(1/q + ((1 - (1/q))/ (1 + q)))) - (1/(1 + q)bQ) \).\(^6\) With the introduction of copying, and assuming that purchasers of originals can capture from copiers the value of partial copying, the market demand curve becomes \( P = a(1 + (1/q) - ((1 + 1/q)bQ) - (r/q) \), where \( r/q \) is the cost of a (partial) copy. In a sense, we have already examined the case in which \( 1/q \) is close to one, i.e., where a complete copy is desired. There, purchasers of originals and copies, as well as producers of originals benefit if \( r < c \), i.e., if copying is less expensive than producing additional originals. Moreover, all groups are worse off if \( r > c \), unless limit pricing prevails.

At the other extreme are cases in which \( 1/q \) is small, i.e., copiers wish to obtain a small proportion of an original, where the existence of partial copying affects neither the number of originals produced nor their prices. Here, the introduction of copying makes neither producers nor the purchasers of originals worse off and makes partial copiers better off.\(^7\)

**PRICE DISCRIMINATION**

Using the previous analysis, it is straightforward to analyze the case in which different prices are charged to different users, depending upon whether copies will be made from the originals that they purchase. Although it is common for the price of journals to be higher for libraries than for individuals,\(^8\) more refined forms of discrimination

\(^6\)Note that the "intercept" of the demand curve below \( a/q \) is simply the extension to the vertical axis of the section of the demand curve with slope \( b(1 + (1 + q)) \).

\(^7\)This reflects the assumption that the value that copiers place on an original is proportional to the amount copied.

\(^8\)E. A. Dyl, "A Note on Price Discrimination by Academic Journals," 53 *Library Quarterly* 161 (1983), reports that for 76 academic economics journals, the mean library price was 148 percent of the mean individual price. When this is broken down by publisher type, the figures are 126
based on frequency of copying appear not to be practiced.$^9$

Nevertheless, it is possible to analyze the effect of introducing a simple form of discrimination in which different prices are charged to copiers and non-copiers.

Price discrimination permits the decoupling of the interests of copiers and non-copiers. The price charged to non-copiers is neither raised or lowered when copying is practiced so that their welfare is independent of copying. Similarly, whether copiers are better or worse off when copying is introduced does not depend on the behavior of non-copiers. Unlike the case in which both groups of users pay the same price, where a higher price can be charged to copiers they benefit from copying only if $r < c$.

**MONOPOLISTIC COMPETITION**

To this point any effect that a change in producer profits may have on the number of first copies produced has been ignored. And, although this Note does not attempt to analyze this effect in any detail, a few remarks are in order here. Consider the case analyzed above in which there were only copiers and where $c < r < P^*$, so that inefficient copying occurs. In that case, both consumers and producers were made

percent, 136 percent, and 191 percent for professional associations, universities, and private publishers, respectively. Moreover, where 80 percent of the private publishers discriminated, less than half of the professional associations and only about 58 percent of the universities did so. When only discriminators are considered, private publishers charged libraries 224 percent of the individual price with the figures for professional associations and universities being 161 and 156 percent, respectively. The author reports, however, that "the difference is statistically meaningful only for private publishers" (at 163). A. F. Spilhaus, "Page Charges," in *Economics of Scientific Journals*, op. cit. at 25, reports that "In publications issued by societies...the member receives journals at a rate near the production costs and libraries pay from 2 to 10 times more to make up the difference between actual page charge collections and the first-copy costs."

$^9$Many publishers have, however, sought an arrangement under which they would receive royalties based on the number of copies made. See L. Weinberg, "The Photocopying Revolution and the Copyright Crisis," 28 *The Public Interest* 99 (1975) for a discussion of these efforts. Under the present copyright law, permission of the publisher is required for certain types of copying, but others are considered fair use or non-infringing. Moreover, it is clear that permission is not obtained for all infringing uses.
worse off by the introduction of copying. In the long run, the reduced producer profits will cause some firms to exit from the industry or, at least, some first copies not to be produced. The elimination of these products causes the demand for the remaining products to increase. However, the overall effect of these changes cannot be assessed a priori, since it is not generally possible to determine where a reduction in the number of monopolistically competitive firms leads to an increase or a reduction in welfare. A reduction in the number of first copies may lead to a reduction in welfare, but it could also increase welfare if it eliminates some "excessive" product variety.

CONCLUSION

In the models employed in this Note, several significant conclusions emerge about the effect of copying on the supply of intellectual property:

1. The introduction of copying will increase consumer welfare and producer profits in the short run if (a) private reproduction costs are lower than the production costs of the producer, and (b) the price of originals can be raised to reflect the value of the copies that are made from them.

2. Copying may reduce both consumer welfare and producer profits even when it is in the private interest of consumers to copy. This occurs where the cost of private reproduction exceeds the production costs of the producer but is less than the price of originals, and profits are maximized by raising the price of originals. These inefficiencies result from the inability of consumers to enter enforceable agreements that prohibit copying.

3. The introduction of copying may cause producers to reduce their prices to discourage copying if private reproduction cost is close to the price of originals before copying is introduced. The result is to make consumers better off and producers worse off than before the introduction of copying.

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4. Where some originals are copied but others are not, where the price of originals is raised when copying becomes possible, and where the same price is charged to all consumers, purchasers of originals that are not copied are necessarily made worse off than if there were no copying. At one extreme, the price of originals is set so high that only originals that will be copied are purchased. At the other, the price of originals does not change as a result of copying but copiers contribute little or nothing to the cost of first copies. However, although non-copiers are necessarily worse off, profits and total consumer welfare may rise.

5. The introduction of copying may cause producers to reduce the price of originals even where only some originals are copied. Here, all consumers are better off and producers are necessarily worse off.

6. Where copiers demand the use of only a small portion of an original and where there are users who demand an entire original for their own use, the existence of copiers makes neither the purchasers of originals nor producer worse off and makes copiers better off. However, the greater the proportion to be copied, i.e., the more that copying is a substitute for the purchase of an original, the more questionable becomes this conclusion. If almost an entire original is to be copied, the effect of copying on producers and other consumers will depend on the relationship between private reproduction costs and the production costs of the producer.

7. The long-run effect of private copying on consumer welfare cannot be determined a priori even if copying reduces consumer welfare and profits in the short run. This is because inefficient copying, by reducing the number of "first copies" produced, may reduce "excessive" product variety.

Application of the model developed in this Note to the question of whether to subject copying to copyright liability is clearly a long way away. Nonetheless, the results reported here indicate that such
applications must focus on the extent of copying, the incremental costs of publishing, and the costs of copying, among other factors. Moreover, we are confident that such an inquiry will confirm Breyer's assertion that "...the desirability of copyright protection will vary from one type of 'writing' to another. One must know facts about the particular industry involved before one can weigh the various costs and benefits associated with copyright protection."61

61Breyer, op. cit., at 351.