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Harry C. Benham
University of Oklahoma

Jennifer L. Wagner
Roosevelt University

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SOFTWARE PUBLISHING AND THE ECONOMIC IMPACT OF COPYING

Harry C. Benham
Division of Economics
University of Oklahoma

Jennifer L. Wagner
Department of Management
Roosevelt University

ABSTRACT

Unauthorized duplication of microcomputer software is apparently commonplace. Recent decisions by major software publishers to drop "copy protection" may well result in even more unauthorized duplication. This paper addresses the impact of unauthorized software duplication on software publishers' profits. Software "clubs" of the type suggested by Buchanan (1965) are posited as providing a mechanism whereby software publishers can indirectly appropriate revenue for unauthorized software copies. It is shown that, under certain conditions, software publishers' profits may actually increase when users can make unauthorized copies.

Recent growth in microcomputer sales has brought with it growth in the demand for microcomputer software. Coincident with this growth has been an increased incidence of unauthorized duplication of microcomputer software. Software publishers responded to unauthorized duplication of their products with various forms of "copy protection." Even with "copy protection devices," the claim has been made that on the order of 50 percent of all microcomputer software currently in use is pirated (DiNacci 1986, p. 126). In 1986, major software publishers began removing "copy protection" from their products. This paper examines the economic effects of copying microcomputer software on software publisher revenues. Currently such copying is unauthorized and illegal. The focus of this paper is on whether it might be in the best interest of the software publisher to authorize (at least implicitly) such copying.

The popular press has treated unauthorized duplication of microcomputer software as an evil directly analogous to theft. Consequently, some articles admonish employers to prevent unauthorized copying by their employees (Cooper and Somervill 1985) and others describe how unauthorized copying injures the software publisher (Sacks 1985). It is claimed that unauthorized copying reduces the publisher's revenue and hence his incentive to develop and bring to market new software products. Since unauthorized copying of software is perceived as a problem, there are also articles listing avenues of legal "protection" available to software publishers (Price and Jones 1986) and articles discussing "copy protection" mechanisms which can be incorporated into the original software product (Small 1985).

Microcomputer software is often thought of as a creative work worthy of protection under copyright laws. But surprisingly, there has been little specific treatment of the economic issues concerning unauthorized copying of software or the impact of software copying on the market for software products. Within the economics literature, unauthorized duplication of microcomputer software falls within the purview of the considerable literature on optimal patents. Recent papers by Novos and Waldman (1984) and Johnson (1985) explicitly refer to unauthorized copying of software. However, the assumptions employed by these authors -- that unauthorized copies are equivalent to originals, that the marginal costs of unauthorized copies vary across individuals, and that the marginal cost of an unauthorized copy exceeds the marginal cost of producing an original -- greatly limit their application to unauthorized duplication of microcomputer software. In the case of unauthorized copies of software, the "quality" of the copy is often below that of the original, particularly if one includes documentation and publisher support of the

product as part of an original software product. Software which can be used to create unauthorized copies is widely available. Thus the marginal cost of an unauthorized copy should not vary substantially across individuals. Finally, the cost of an unauthorized copy may be as low as the cost of a diskette, well below the producer's marginal cost which includes documentation and product support.

This paper suggests that unauthorized copying of software need not adversely impact publishers' revenues. Following Liebowitz (1985), a mechanism is suggested which allows a software publisher to indirectly appropriate revenue from unauthorized copies. Thus unauthorized duplication of software may not reduce incentives to develop new software products.

The remainder of this paper is organized as follows. Section I presents a model of a software publisher's pricing decision when copying is possible. Section II discusses some implications of this model, including the possibility of publishers indirectly appropriating revenue from unauthorized copies. Section III illustrates the essential features of the model with numerical examples. Section IV provides some testable hypotheses based on the model. Finally, Section V contains concluding remarks and suggestions for future research.

I. THE MODEL

The market for a particular software product is considered. The software publisher's product is assumed to be an imperfect substitute for other software products. The effect of this assumption is that the software publisher faces a downward sloping demand for his product. Equation (1) describes the publisher's total costs of producing x units of the product:

$$TC(x) = F + mx \tag{1}$$

where F denotes the fixed costs of developing the software product and mx denotes the variable costs of production and sale of x units of the product. For a microcomputer software product, the cost of an additional unit, m, would include the cost of duplicating a diskette, printing the documentation, and providing some expected amount of support to the purchaser.

Individuals may derive utility from the consumption of one unit of the software product or from the consumption of a copy. Let each individual's valuation of the product be u_i. Further, let individuals differ in their valuations of the product by having u_i distributed over the interval [0,U] according to a density g(.) that is continuously differentiable and nonzero in the specified interval. If the software product sells for a price of P, an individual's net benefit from the purchase of the product would be $u_i - P$. If obtaining an unauthorized copy is impossible, those individuals with positive net benefits from the purchase of the product will purchase the software product.

Consider the publisher's pricing decision when unauthorized copying is effectively prevented. The publisher's problem is to select the price, P_n, which maximizes profits or

$$\pi = \max_P \int_P^U (P-m)g(x)dx - F. \tag{2}$$

A necessary condition for the maximization of equation (2) is

$$\frac{d\pi}{dP} = \int_P^U g(x)dx - (P-m)g(P) = 0. \tag{3}$$

This condition can be rearranged to yield the traditional "marginal cost equal to marginal revenue" condition,

$$mg(P) = Pg(P) - \int_P^U g(x)dx \tag{3a}$$

where the first term on the right hand side is the additional revenue from sales to individuals with valuation P and the second term is the revenue lost as a result of lowering the price to P. Further manipulation of equation (3) yields a profit maximizing price of

$$P_n = m + \frac{\int_{P_n}^U g(x)dx}{g(P_n)} \tag{4}$$

where the price is equal to the variable cost plus a margin comprised of the ratio of total sales to marginal sales.

Consider now the prospects of individuals obtaining unauthorized copies of the software product. How is an original located for the purpose of making an unauthorized copy? What are the incentives for the owner of an original to allow copying? A software club in the sense of Buchanan (1965) is proposed to answer these questions. In such a club, a number of individuals come together to purchase one original and make copies for the remaining club members. For instance, a club could consist of three friends or business associates who arrange to have one purchase a word processor, one purchase a spreadsheet, and one purchase a database management program and then share their programs. Alternatively, a "club" need not be so formal; owners of software could meet, discuss their software holdings, and agree to swap. Participants are willing to allow their software to be copied in exchange for receiving a copy of some other software. Other examples of clubs could include family members or workers in a particular department or office - situations where one purchased copy is used by more than one individual.

What is the value or utility of an unauthorized copy to a club member? In this paper, it is argued that the "quality" of an unauthorized copy is less than the "quality" of the original. Although the software code may be an exact duplicate of the original, the user of an unauthorized copy will not have access to equivalent documentation or support from the publisher. Often only the software code is copied, leaving the unauthorized user with no documentation. Sometimes the manual is also copied. However, a photocopy of the manual may be illegible in places, be missing pages, and is in a less convenient package. Let the net benefit of participating in a software club of size n be given by

$$\delta(n)u_i - c(n,P).$$

In the above expression, the $\delta(n)$ term captures the reduced quality of unauthorized copies and c(n,P) is the effective cost of the unauthorized copies to members of a club of size n. The following specific assumptions are made:

a) $0 < \delta(n) < 1$ for $n > 1$,
b) $\delta(n) > \delta(n+1)$,
c) $c(n,P) \leq P$,
d) there exists n' such that $\delta(n) - \delta(n+1) > c(n,P) - c(n+1,P)$ for all $n > n'$.

Assumption a) states formally that the club's copies are inferior to the original. Assumption b) indicates that the "quality" declines as club size increases. The reasoning behind this assumption is that the "quality" reduction is related to the availability, quality, or access to documentation and publisher support. The larger the club, the further each member is from the documentation and publisher support.

Assumption c) indicates that the cost to club members of unauthorized copies does not exceed the purchase price of an original. If this assumption were violated, joining a club would always be less desirable than purchasing an original and there would be no unauthorized copying.

The final assumption, assumption d), is critical. It indicates that at some point the decline in the "quality" of the copied software exceeds the cost savings from additional club members. This condition will be met provided that quality deteriorates sufficiently fast while cost savings decrease at a decreasing rate. Those who have attempted to read a photocopy of a software manual which heavily uses color would acknowledge that quality can decline rapidly. The behavior of costs as club size increases can be predicted. Normally, one would expect that the cost of an unauthorized copy would decline with club size. Indeed, if copies can be made at a cost of c and club members share equally the purchase of the original, then $c(n,P) = c + P/n$ declines in n where P is the cost of an original and n is the number of club members. However, software clubs are engaged in illegal activities. If the club's activities are detected and the club members prosecuted, the penalty could be substantial. Thus c(n,P) should perhaps contain an expected penalty term. Surely larger software clubs are more likely to be detected than small clubs. Thus c(n,P) could increase with club size for larger values of n. With quality deterioration and the probable behavior of c(n,P) discussed here, assumption d) seems reasonable.

Within this context, an individual will purchase an original (join a club of size one) if

$u_i - P > 0$ and (5a)

$u_i - P > \delta(n)u_i - c(n,P)$ for all $n \geq 2$. (5b)

Condition (5a) indicates that the individual's net benefit from the purchase of an original is positive. Condition (5b) indicates that this same net benefit exceeds the net benefit that would result from joining a club of any size.

An individual will join a software club of size n if the net benefit from doing so is positive and exceeds the net benefit of either joining clubs of other sizes or purchasing the product. Formally, an individual will join a club of size n if

$$\delta(n)u_i - c(n,P) > 0, \quad (6)$$

$$\delta(n)u_i - c(n,P) > u_i - P, \quad (7)$$

$$\delta(n)u_i - c(n,P) > \delta(n+1)u_i - c(n+1,P), \text{ and} \quad (8a)$$

$$\delta(n)u_i - c(n,P) > \delta(n-1)u_i - c(n-1,P). \quad (8b)$$

Condition (6) indicates that the net benefit from joining a club of size n is positive. Condition (7) indicates that the net benefit from joining a club of size n is greater than the net benefit from purchasing an original. Finally, conditions (8a) and (8b) indicate that the net benefit of belonging to a club of size n dominates the net benefit of belonging to clubs of any other size.

Figure 1 illustrates the relationship between an individual's valuation of the software product, u_i, and club membership. Net benefit schedules are drawn for purchasers of originals (clubs of size one), clubs of size two, and clubs of size three. Individuals whose valuation of the product exceeds U(1) purchase the software since the net benefit from purchasing the software exceeds the net benefit of all other alternatives. Individuals whose valuation of the product falls between U(2) and U(1) join clubs of size two since it is in this range that the net benefit of belonging to a club of size two exceeds that of all alternatives. Similarly, individuals whose valuations of the product falls between U(P) and U(2) join clubs of size three. Finally, individuals whose valuations of the product are below U(P) neither purchase nor copy the product since neither activity would yield a positive net benefit. The relationship between product valuation and club size illustrated in Figure 1 becomes an important feature of this model.

The points at which individuals switch to a club of size n, U(n), can be determined from conditions (5) through (8). The valuation level at which individuals switch to clubs of size one (purchase originals), U(1), follows from condition (5b) and is given by

$$U(1) = \underset{n}{\text{Max}} \left[\frac{1}{1-\delta(n)} [\, P - c(n,P) \,] \right] \quad (9)$$

Individuals with valuations u_i where

$U(n) < u_i < U(n-1)$ and $u_i > U(P)$

will join clubs of size n. The switch point U(n) derived from condition (8a) is given by

$$U(n) = \frac{c(n+1,P) - c(n,P)}{\delta(n+1) - \delta(n)} \quad (10)$$

Finally, the lowest valuation level to yield a non-negative net benefit, U(P), is obtained as

$$U(P) = \underset{n}{\text{Min}} \{\, u_i \mid \delta(n)u_i - c(n,P) = 0 \,\} \quad (11)$$

It can be shown that $U(n) < U(n-1)$.[1]

When copying occurs, the publisher does not sell one unit of the product for each individual using the product. Rather, the publisher sells one original to each club. Equations (9), (10), and (11) can be used to define n(u,P), the size of club which an individual with valuation u would join if the software product were sold at a price of P. The density, g(u), indicates the number of individuals with valuation level u. If those individuals are members of a software club of size n(u,P), then sales to individuals with evaluation level u would be given by g(u)/n(u,P). In the presence of clubs, the publisher's market contains individuals with valuations as low as U(P).

The publisher's problem in an environment where software copying clubs may exist is to select a price, P*, which maximizes the publisher's profits or

$$\pi = \underset{P}{\text{Max}} \int_{U(P)}^{U} (P-m)\frac{g(x)}{n(x,P)}\,dx - F \quad (12)$$

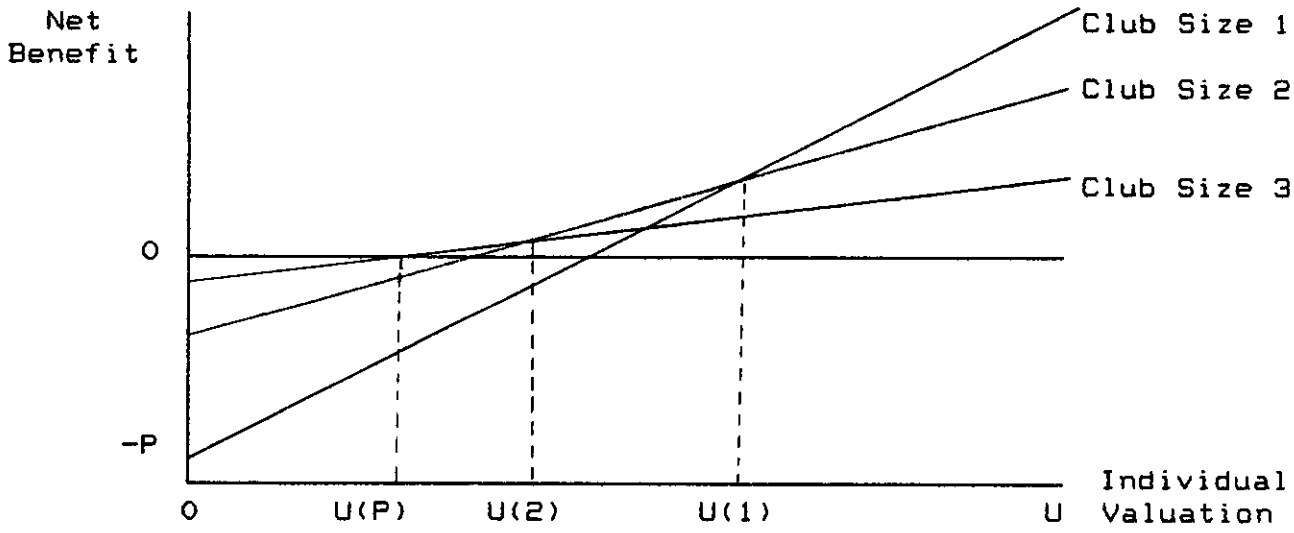

Figure 1.

where $U(P) < P$ is the lowest valuation level for which a club of any size yields a positive net benefit. A necessary condition for maximizing equation (12), assuming an internal solution, is

$$\frac{d\pi}{dP} = \int_{U(P)}^{U} \frac{g(x)}{n(x,P)}\,dx - (P-m)\frac{g(U(P))}{n(U(P),P)}\,U' = 0 \qquad (13)$$

Like equation (3), equation (13) can be arranged in the traditional "marginal cost equals marginal revenue" form,

$$m\left[\frac{g(U(P))}{n(U(P),P)}\right]U' = P\left[\frac{g(U(P))}{n(U(P),P)}\right]U' - \int_{U(P)}^{U} \frac{g(x)}{n(x,P)}\,dx \qquad (13a)$$

where the marginal revenue on the right hand side is comprised of two terms: additional revenue from sales generated by lowering the price and revenue lost on previous sales due to the price reduction. The interesting new feature of equation (13a) is the way in which the quantity sold responds to a change in price. First there are sales to clubs of size n,

$$\frac{g(U(P))}{n(U(P),P)}$$

Second, there is the U' term indicating how the valuation level at which clubs form responds to a change in price. Further manipulation of equation (13) results in a profit maximizing price of

$$P^* = m + \frac{\int_{U(P^*)}^{U} \frac{g(x)}{n(x,P^*)}\,dx}{[g(U(P^*)) \,/\, n(U(P^*),P^*)]\,U'} \qquad (14)$$

Notice that since clubs purchase the software product, the lower limit of integration, $U(P^*)$, is the valuation at which clubs cease to form. As was the case in equation (4), the profit maximizing price is the marginal cost plus a margin comprised of the ratio of total sales to marginal sales.

II. DISCUSSION OF THE MODEL

There are two interesting features of the situation in which a publisher sells a software product in an environment where software clubs exist. The first is that, although software clubs exist to make unauthorized copies of the software, they also generate sales, sales which might not have occurred if copying were effectively prevented. The second feature is the sorting or "self-selection" of software users into clubs of different sizes according to their valuations of the product. Such segmentation of a market can generally be used by the seller to increase revenues through price discrimination. In this case, the segmentation provides a mechanism through which the publisher can indirectly appropriate revenue from the unauthorized copies.

Figure 2 illustrates the relevant alternatives. Panel a) depicts the situation with no unauthorized copying. The publisher's downward sloping demand curve is given by D. The maximum profit resulting from the equation of marginal costs (MC) and marginal revenues (MR) is represented by the shaded area. The software is sold at a price of P and the quantity sold is Q.

The potential for a publisher to indirectly appropriate revenue by exploiting club-induced segmentation of the market is depicted in panel b). The highest price shown on the vertical axis, P_1, is the price charged by the publisher. At this price, Q_1 originals are sold to individual users. Assuming the copies are made at a zero cost (c=0), $(Q_2-Q_1)/2$ originals are sold at a price of P_1 to clubs of size two. The effective price paid by the $Q_2 - Q_1$ club members is thus $P_2 = P_1/2$. Similarly, the effective price to members of clubs of size three is $P_3 = P_1/3$ with $Q_3 - Q_2$ users. Thus the publisher's profit is represented by the sum of the areas of the stair-stepped shaded rectangles in panel b).

The kernel of this paper is that the shaded area in panel b) may exceed the shaded area in panel a). With software clubs, the possibility exists for the publisher to gain the increased revenue associated with effective price discrimination. Further, software users implement the price discrimination by self-selecting themselves into clubs of various sizes.

III. NUMERICAL EXAMPLES

Numerical examples will illustrate the phenomenon of unauthorized copying allowing the publisher to increase profits. The attraction of these examples is that they emphasize the two major factors in the above model: the publisher's pricing decision and the effect of "quality" deterioration of unauthorized copies.

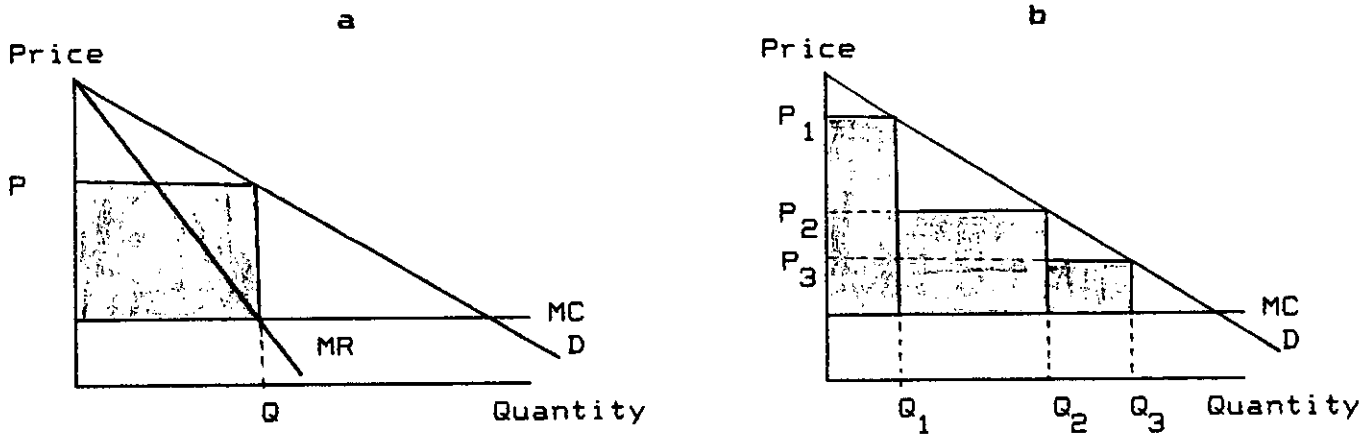

Figure 2.

Values for the model's "parameters" are required for these examples. The publisher's fixed cost, F, does not affect the pricing decision or the quantity sold; it affects only profits. A value of 500 is used for F. The publisher's marginal costs consist of reproducing the program disks, printing the documentation, distributing the product, and providing some user support. The marginal cost parameter, m, is set to 10 as a reference value. Club copying costs are assumed to be given by $c(n,P) = c + P/n$, where three different values of c, the cost of an unauthorized copy, are used to illustrate the effect of copying costs on the extent of copying and the publisher's revenue. For reference, Table 1 contains the values of these "parameters." To be concrete, these values may be considered as dollar amounts.

The density function, g(.), sets both the size of the market and the distribution of individual valuations within the market. For convenience, the size of the market is set to 100. Since the distribution of valuations within the market affects the publisher's pricing decision and unauthorized copying, two market distributions are considered. The first is a uniform distribution with

$$g(x) = 1, \quad 0 \le x \le 100.$$

Specifying a uniform distribution for g(.) on the interval [0,100] provides easy translation between valuation levels and the quantity sold. For example, if individuals with valuations in excess of 75 purchase the product, then 100 - 75 or 25 units would be sold.

The second distribution is triangular with

$$g(x) = \begin{cases} .04x, & 0 \le x \le 50 \\ 4 - .04x, & 50 < x \le 100 \end{cases}$$

With this distribution, the easy correspondence between valuation and quantity sold is lost. However, a symmetric, unimodal distribution may more accurately reflect "real world" valuations. When unauthorized copies cannot be made, these parameter values are sufficient for determining the publisher's price, quantity sold, and profits. For the uniform distribution, solution of equation (4) yields a profit maximizing price of 55, quantity sold of 45 units, and total revenue of 2475, resulting in profits of 1525. For the triangular distribution, solution of equation (4) yields a profit maximizing price of 44.29, quantity sold of 61 units, and total revenue of 2702, resulting in profits of 1583.

In order to determine the outcome when it is possible to make unauthorized copies, values of $\delta(n)$ must be established. The first set of values for $\delta(n)$ was chosen to illustrate a situation where copying initially has little impact on the quality of the software product. Given the $\delta(n)$ values in Table 2, no one would purchase an original and the majority of sales would go to clubs of size two. If c=0, the publisher's profits are maximized by charging a price of 100 rather than the no-copying price of 55. In this case, copying has clearly reduced sales (23.64 units rather than 45), but profits have increased from 1525 to 1627.60. When c=1 or c=2, unauthorized copying is reduced, yet profits remain above their no-copying level.

Table 1. Parameter Values

Parameter	Value	Meaning
F	500	Publisher Fixed Cost
m	10	Publisher Variable Cost
c	0,1,2	Cost of Unauthorized Copy (exclusive of purchasing the original)

Table 2. Uniform Distribution

Club Size	$\delta(n)$	C=0, P=100.00		C=1, P=99.00		C=2, P=98.00	
		Q-Sold	Revenue	Q-Sold	Revenue	Q-Sold	Revenue
1	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2	.95	22.22	2222.00	22.50	2227.50	22.78	2232.44
3	.65	1.42	142.00	.90	89.10	0.37	36.26
4	.40	0.00	0.00	0.00	0.00	0.00	0.00
Totals		23.64	2634.00	23.40	2316.60	23.15	2268.70
Profits		1627.60		1582.60		1537.20	

The triangular distribution yields results comparable to those shown in Table 2. Table 3 uses the same values of $\delta(n)$ as Table 2. In Table 3 the majority of sales are to clubs of size two. For all three values of c, the publisher's price is substantially above the no-copying price of 44.29 and the resulting profits are greater than the no-copying profits of 1583. Thus the self-selective behavior of club members allows the publisher to effectively acquire revenue for unauthorized copies.

Tables 4 and 5 utilize a second set of values for $\delta(n)$. These values illustrate a situation where copying greatly reduces the quality of the software product. Table 4 presents the publisher's maximum profit under the different values for c assuming a uniform distribution. When copying has such an adverse impact on product quality, sales to individuals are reduced only slightly from the 45 units which would have occurred if copying were not possible. Additional revenues are earned on

Table 3. Triangular Distribution

Club Size	$\delta(n)$	C=0, P=81.50		C=1, P=79.50		C=2, P=78.00	
		Q-Sold	Revenue	Q-Sold	Revenue	Q-Sold	Revenue
1	1.00	0.00	0.00	0.00	0.00	0.00	0.00
2	.95	29.50	2404.25	30.49	2423.95	31.22	2435.16
3	.65	2.02	164.63	1.07	85.06	0.15	11.70
4	.40	0.00	0.00	0.00	0.00	0.00	0.00
Totals		31.52	2568.88	31.56	2509.01	31.37	2446.86
Profits		1753.75		1693.40		1633.16	

Table 4. Uniform Distribution

Club Size	$\delta(n)$	C=0, P=58.00		C=1, P=57.50		C=2, P=57.50	
		Q-Sold	Revenue	Q-Sold	Revenue	Q-Sold	Revenue
1	1.00	42.00	2436.00	42.50	2443.75	42.50	2443.75
2	.50	0.00	0.00	0.00	0.00	0.00	0.00
3	.40	3.22	186.76	2.36	135.70	1.53	87.97
4	.20	0.00	0.00	0.00	0.00	0.00	0.00
Totals		45.22	2622.89	44.68	2579.45	44.03	2531.72
Profits		1670.56		1630.85		1591.42	

club sales so that, in every instance, the publisher's profit exceeds the no-copying level of 1525. Table 5 displays similar results for the triangular distribution. Thus increased publisher profits can be obtained for a variety of values of $\delta(n)$, underlying distributions, and copying costs when copying is possible.

IV. TESTABLE IMPLICATIONS

A number of the assumptions employed in developing the model presented above are potentially testable as are the model's implications. That the quality of software declines when unauthorized copies are made is testable. Further, the amount of quality

Table 5. Triangular Distribution

Club Size	$\delta(n)$	C=0, P=47.00		C=1, P=46.00		C=2, P=45.50	
		Q-Sold	Revenue	Q-Sold	Revenue	Q-Sold	Revenue
1	1.00	55.82	2623.54	57.68	2653.28	58.60	2666.30
2	.50	0.00	0.00	0.00	0.00	0.00	0.00
3	.40	4.50	211.50	2.99	137.54	1.52	69.16
4	.20	0.00	0.00	0.00	0.00	0.00	0.00
Totals		60.32	2835.04	60.67	2790.82	60.12	2735.46
Profits		1731.84		1684.12		1634.26	

deterioration may depend upon characteristics of the software product. For example, an unauthorized copy of a product which is menu-driven with extensive on-line "Help" facilities may suffer little quality decline. Alternatively, an unauthorized copy of a product which is command-driven with a complex set-up procedure employing specialized device drivers may suffer considerable quality decline.

A second testable implication concerns club sizes. In the model, software club sizes were self-limiting. Although members of software clubs may be reluctant to provide information on their activities for fear of prosecution, specialized survey research techniques may be able to elicit appropriate data. The key empirical issue is that the clubs be small.

In the numerical examples, publishers were able to indirectly appropriate revenue from unauthorized copies by increasing the price of the original. Comparison of "copy protected" and "unprotected" software prices should confirm that prices increase when copying is possible. On this point there is some anecdotal evidence. One interesting phenomenon has been the release of both "copy protected" and "unprotected" versions of the same software product. In every instance, the "unprotected" version commands a substantial price premium. One popular word processor, for example, is available with "copy protection" for $75 while the "unprotected" version sells for between $200 and $250. Another example is provided by a memory-resident program available in "copy protected" and "unprotected" versions. The publisher reports that the more expensive "unprotected" version has outsold the "copy protected" version by a factor of five to one (Carroll 1986, p. 37). While "copy protection" schemes may detract from the product and account for some of the price differential, one could also attribute the price differential to whether or not more than one individual is likely to use the product.

Another piece of anecdotal evidence is the lack of market success of software using a hardware "lock." Hardware "locks," physical devices which must be present in or on the microcomputer in order to use the software, have existed for a number years. The few software products which utilize these devices are largely unknown despite their functionality and their having preceded now popular products in the market. One such "locked" product has recently removed its hardware lock and raised its price approximately 30 percent.

A final testable implication of the model is that software publishers' profits may be increased by copying. The use of multivariate techniques may detect a positive correlation between profits and the extent to which the software has been copied, taking suitable covariates into account. The availability of third-party documentation and instruction manuals could serve as a proxy for the unobserved copying activity.

V. CONCLUSIONS AND FUTURE RESEARCH

The model and the numerical examples suggest that unauthorized copying of microcomputer software does not necessarily impact adversely upon the revenue or profits of software publishers. By adjusting prices to reflect unauthorized copying by users, it may actually be possible for publishers to achieve higher profits.

The arguments presented in this paper should generate further investigation of the effects of unauthorized duplication of microcomputer software. The testable implications set forth in the previous section are obvious candidates for further research. In addition, several other topics are deserving of attention. Additional understanding of the nature, causes, and consequences of quality deterioration is needed. Estimates of "real world" product valuation distributions, publisher marginal costs, and the costs of unauthorized copying are required. Finally, it would be desirable to develop a general characterization of necessary conditions under which copying increases publisher profits.

ENDNOTES

[1] Berglas (1976) has also shown that individuals sort themselves into clubs whose members have similar preferences.

[2] This assumption is not necessary. It serves only to simplify the diagram. Similar results are obtained with $c > 0$.

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