Economic Issues of Intellectual Property Rights and Pricing for Digital Information on Computer Networks

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ABSTRACT

ECONOMIC ISSUES OF INTELLECTUAL PROPERTY RIGHTS AND PRICING FOR DIGITAL INFORMATION ON COMPUTER NETWORKS

by James F. Cole

This thesis examines economic issues of intellectual property rights and pricing for digital content on computer networks. Most digital content is a freely available open-access resource. Consumption is non-rivalrous; open-access externalities such as overuse do not occur. Underproduction can occur. People's privacy is at risk due to the collection of meta-information.

Both legal and technical means are developing to protect digital content rights. Copyright systems create costs as well as benefits. Cryptographic-based technologies might obviate the need for copyright by lowering transaction costs so that contracts can efficiently govern every sale and use. Increased rights protection decreases the social welfare loss due to underproduction, but may increase the loss due to under-utilization.

These developments threaten the fair use doctrine, which could impede societal progress. Despite these technical and legal developments, much content will continue to be freely available.

Firms have ample opportunity to practice price discrimination in digital content markets.

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1. Introduction

This thesis examines economic issues of property rights and pricing for intellectual property available via computer networks. By definition, this property is in digital form.

1.1 The Economic Issues of Intellectual Property on Computer Networks

The increase in the number and interconnectedness of computer networks, and the characteristics of digital information stored on them has implications for both intellectual property rights protection and pricing of information goods.

Intellectual property rights protection such as copyright exists not for ideas, which are considered to be the collective property of humankind, but for a particular expression of an idea. As Jussawalla puts it, "Copyright protects the words, but not the ideas expressed" (Jussawalla, 1992, p. 17). Violating someone's intellectual property rights involves creating an unauthorized copy of the good. In the past, this required producing a counterfeit physical object, such as a book, map, or recording. This activity carried a non-trivial cost. Digital intellectual property, however, is disconnected from the physical plane upon which traditional intellectual property rights protection is based (Barlow, 1994).

The cost of copying and redistributing digital information over computer networks is negligible. In fact, for many people who connect to the Internet via their company's or university's computer system, the cost of duplication is zero; their only costs are their search costs. This attribute of digital intellectual property, or *digital content*, forces a re-analysis of intellectual property rights protection and digital information goods pricing.

There are three aspects of intellectual property rights protection for digital content: economic, legal, and international (involving treaties such as GATT) (Jussawalla, 1992). This paper does not examine international issues, and considers legal issues only briefly. This paper focuses on the following economic issues of intellectual property rights and pricing:

1. Digital intellectual property on a network is an open-access resource. Which externalities typical of open-access resources also affect digital intellectual property? Which problems are not applicable? What types of technology can enhance of digital intellectual property on networks?
2. How does increased protection of digital intellectual property from unauthorized duplication and use affect efficient use of those resources?
3. How does digital intellectual property fit into traditional economic models for information pricing? What new types of value creation does this content enable? Who captures this value?

Each issue is examined in detail in a separate chapter. Before examining these issues, a basis for understanding the unique nature of intellectual property rights protection for digital content on computer networks must be created. The following sections examine the nature of computer networks and the digital information stored on them in more detail.

1.2 The Nature of Computer Networks

Computer networks consist of three structures:

- The network's infrastructure
- End-users' computers connected to the network
- The information available in digital form via the network (the network content)

The network infrastructure consists of both hardware and software. The hardware includes the routers, modems, cables and other equipment that physically transport data from point to point. The software includes computer programs that run on the network to facilitate access to data and make it useful as information. Examples include *World Wide Web servers*, which store and retrieve content for Web browser programs such as *Netscape Navigator* and *Mosaic*; search engines, such as *WebCrawler* and *Lycos*, which enable users to find specific content anywhere on the Internet; and organizing programs such as *Yahoo* and *Global Network Navigator (GNN)*, which provide structure to the information on the Internet. Without infrastructure, the network is like a library with random piles of books, no card catalog, no organizing principles such as the Dewey Decimal System, and no check-out desk.

The second structure, end-user computers connected to the network, gives people access to network content. Without this input and output (I/O), the network is like a library that is always closed.

The third structure, network content, adds value to the network. Without content, the network is like a library without books.

The growth of computer networks has been rapid and two-dimensional. Both the number of individual networks and the number of interconnected networks has grown. The number of individual networks has grown as a result of the increasing number of personal computers in use. The growth in network interconnections is a result of the desire to access and share information with other computer users. The Internet, which is a network that connects smaller networks, is the primary example of the increase in the number of interconnected networks. In January 1989, only 247 networks were connected to the Internet. In January 1995, 46,318 networks were connected. This number is projected to increase to 105,155 in 1996 (Hoffman, Novak & Chatterjee, 1995). The growth in the number of people using the Internet has been similarly swift; Internet use in the U.S. doubled in the last six months of 1995 (Reuters, 1996).

1.3 The Nature of Digital Information

All information stored on computer networks is digital. Digital information exists simply as a collection of *bits*, usually stored on some type of magnetic media such as a disk drive. Although stored as simply a series of ones and zeroes, digital information can be extremely rich in both content and format. Current examples of rich content and formatting that are stored digitally include:

- Music on CDs
- Movies on videodiscs
- Electronic encyclopedias, which include text, pictures, movies, and sound clips
- The complete text of major daily newspapers, such as the *Wall Street Journal* and *New York Times*, available via commercial online services

Much of this digital information is intellectual property owned by a person or business. For instance, the *Wall Street Journal* retains copyright in its stories, whether published in the newspaper or online. The key difference between a newspaper article published in the paper and one published online is that readers can duplicate the online version very easily. This is true of all digital intellectual property, or *content*, no matter how complex and richly formatted. Because it is stored simply as bits, it is very easy to duplicate with the appropriate equipment, and duplication does not damage the original.

This is particularly true of digital content stored on computer networks, since the equipment used to find and view it, the computer, is the same equipment used to duplicate it. Unlike copying a music CD to a cassette tape, no extra machinery is necessary. Furthermore, every copy is identical to the original;

there is no difference in quality between the original and a copy. These attributes make consumption of content over computer networks *non-rivalrous.*

Samuelson points out two additional characteristics of digital content that affect its economics. First, unlike traditional works, digital content can often be edited, enhanced, or even used in ways completely different from those originally intended. Both the original author and consumers of digital content have this ability to rework and reuse digital content. Second, digital content can be experienced non-linearly, via hypertext links and text searches. This characteristic can make digital content more valuable than its non-digital equivalent (Samuelson, 1991). For instance, a digital version of a textbook could allow a student to click on a topic of particular interest; the "textbook" would then present the student with more detailed information about that topic. This additional information could come from various sources, not just from within the textbook. The textbook could also continually update its contents by including new information found on the computer network.

The problems of intellectual property rights protection for digital content on computer networks are increasing in scope and importance. The number of networks, and their interconnectedness, is growing rapidly. The amount of intellectual property available via these networks is also growing rapidly. The digital form of this information makes it very easy to duplicate. Furthermore, all duplicates are exact copies of the original. Thus, intellectual property rights protection and pricing are fundamental issues, affecting both the incentives to create new content and the availability of existing content. This form of the information also creates new types of value, which affect both intellectual property rights and digital information goods pricing.

2. Open Access Externalities and Digital Intellectual Property

> *If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of everyone, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the less, because every other possesses the whole of it. He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me. — Thomas Jefferson* (Barlow, 1994)

Intellectual property accessible via a computer network such as the Internet is an open-access resource. (For an overview of different resource management regimes, see (Cole, 1994).) Open-access resources often suffer from several types of externalities, including the following:

- Overuse beyond the socially optimal point
- Intertemporal externalities

- Underproduction
- Inability to transfer resources to higher-value uses

Because of its non-rivalrous nature, some of these problems are applicable to digital content, and some are not. Each externality is examined in a section below. This chapter also describes technical means under development that are designed to secure property rights in digital content.

2.1 Overuse Beyond the Socially Optimal Point

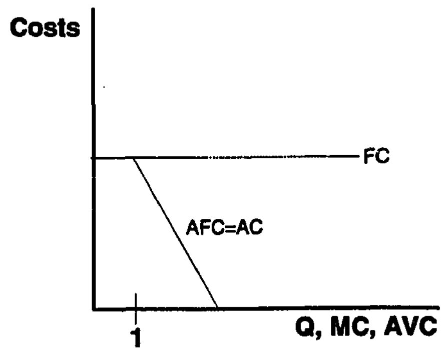
External diseconomies occur when the marginal social cost of a choice exceeds the marginal private cost. Individuals determine how much to consume based on their marginal private cost, but society must bear the greater marginal social cost. Overuse beyond the socially optimal point occurs because decision-makers do not bear the full social cost of their actions. A famous example of overuse beyond the socially optimal point is Hardin's *Tragedy of the Commons,* where each herder chooses to continue adding grazing animals to a shared rangeland, taking into account only the marginal private cost of doing so. The social cost, however, includes the lower productivity to all herders as the range degrades from overuse by too many animals.

There are at least three network-based resources that could potentially suffer from overuse: digital content, network infrastructure, and network usage data. Each of these is examined below.

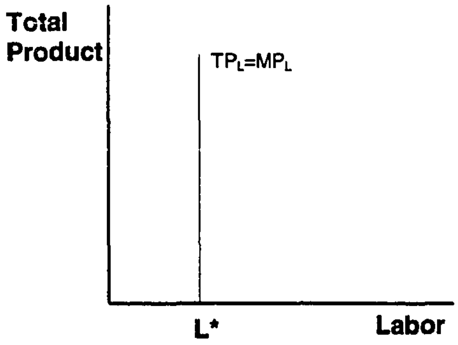
2.1.1 Overuse of Digital Content

Unlike rangeland or even a physical information good such as a book, most digital content is non-rivalrous, so one person's use doesn't diminish another's ability to use the same content. The production function for non-rivalrous content is not convex; it's vertical. This can be shown using simple microeconomic analysis.

A firm uses a fixed amount of labor to produce one unit of output of digital content, but that single unit can be duplicated endlessly for zero cost. Thus, the marginal cost of production and the average variable cost are zero. The average cost simply equals the average fixed cost.



The total product of labor is infinity. Therefore, the marginal product of labor, which at any point equals the slope of the total product curve at that point, is also infinity.



If the firm is in a competitive market, price equals marginal revenue equals marginal cost $(P = MR = MC)$ at equilibrium, so price equals zero. Because one person's consumption of the good does not diminish another person's ability to also consume the good, marginal social cost equals marginal cost $(MSC = MC)$, and no overuse occurs.

Because the marginal cost of reproducing digital content is zero, optimal resource use would occur if its price were zero. But a zero price would not allow the content producer to cover the costs of producing the content. This would result in static social welfare maximization, but not dynamic welfare maximization. This topic is analyzed in Chapter 3, **Efficiency of Intellectual Property Rights Protection.**

2.1.2 Overuse of the Network Infrastructure

Overuse does affect the network infrastructure by causing congestion, which occurs when too many people attempt to use a resource simultaneously. Network bandwidth, which is the maximum amount of data that can be transmitted over the network at one time, is created via physical devices such as fiber optic cables, servers, routers, and modems, and in the short run is a limited resource. Therefore, congestion can and does occur. If the network is accessed beyond its bandwidth capacity, access time degrades for everyone connected. Thus, the decision by the marginal user to retrieve a large file imposes costs on all those connected. MacKie-Mason and Varian have studied this extensively; see for example (MacKie-Mason & Varian, 1993, 1994a, 1994b). This analysis is beyond the scope of this paper.

2.1.3 Overuse of Network Usage Data

Network usage data describes people's use of the network to obtain information. For example, suppose a terrorist uses the network to try and obtain information about how to create an atomic bomb. He doesn't simply search the network for "how to make an atomic bomb," because such an overt action might draw the attention of law enforcement officials. Instead, he attempts to covertly uncover the desired information by searching for smaller pieces of information, such as "fusion" or "implosion." If law enforcement officials obtain one piece of network usage data, such as the search for information about fusion, little information about the terrorist's information needs is revealed. The person could simply be a college physics student preparing for an exam. But by analyzing a wider range of network usage data, the terrorist's true purpose might be uncovered. This *meta-information* describes the terrorist's information needs.

While most people may want certain people to be able to determine terrorists' true information needs by collecting network usage data and creating meta-information, they might feel differently when their network usage data is collected and used to reveal their information needs. The use of this data to create meta-information has large implications for people's ability to maintain their privacy, especially if it is sold to firms for marketing, or used by government agencies to track people's actions.

Property rights in meta-information about network usage are unclear because the information concerns actions by one party, the network user, but is collected by different parties, typically the network operators and content providers. This information concerns a person's actions, so giving that person a property right in would help them protect their privacy. They could simply choose to not sell this information to other parties. On the other hand, because other entities expend resources collecting and collating the information, they often expect a property right in it.

This problem exists for meta-information collected outside of computer networks as well. For instance, magazines often sell their subscription lists to direct marketers who want to target ads to a specific audience. To some extent, people can prevent this use of "their" meta-information by writing to a direct marketing industry trade group, the Direct Marketing Association, and requesting that their names not be used in this way. But for both technical and legal reasons, the externality created by unclear rights in meta-information collected on computer networks will be more difficult to solve.

Technically, meta-information is much easier to collect and create on computer networks (Phillips, 1994). Information flows occurring outside of computer networks can be captured, collated, and analyzed, but it is more difficult to do so. All of these operations are easier when the information is already stored digitally on a computer network. The raw data from which meta-information can be constructed are generally more easily obtained from transactions occurring on computer networks. Network usage data can easily be gathered by many different entities, including the firm that provides that person's network account, the various network sites the person visited, and even third party "hackers" who spy on others' network activities. Thus, data from which meta-information can be created can be captured on computer networks without people's knowledge, let alone permission.

Legal blocks to collecting non-network meta-information have been erected in common law. An appellate court has held that libraries do not have to reveal borrowers' names to police who lack a warrant, even if the police seek that information to help locate a terrorist. The court ruled that library patrons have a reasonable expectation that such information will remain private, unless they are forewarned that it will not (Phillips, 1994). These legal blocks do not yet exist for the collection of network-based meta-information.

Because privacy is valued by many people, the loss of it to meta-information gatherers means that the marginal social cost of meta-information gathering exceeds the marginal private cost to gatherers. This creates an overuse externality of the data from which meta-information is created. This externality is conceptually similar in cause to problems typical of open-access property regimes, such as fisheries.

This overuse externality is caused by a lack of clear property rights. Intuitively then, it could be reduced by creating clear property rights. In fact, Pezzey says that, "... a fundamental message of economic analysis [is] that once a resource has become scarce, it needs to be owned, and priced, if it is to avoid becoming even scarcer..." (Pezzey, 1992, p. 990). The property rights regime created to reduce the externality can be a private property, common property, or state property system (Cole, 1994).

2.1.3.1 Private Property Solutions

Private property solutions to overuse externalities consist of giving ownership of the scarce resource to entities that then exploit the resource to maximize their benefit. But privacy is created and maintained by *not* collecting, using or disseminating information. A person's privacy is violated by the actions of others, in this case, a meta-information gatherer. This creates a problem that is similar to many Coase theorem-type problems. The Coase theorem states that an efficient allocation of rights is obtained via negotiation, regardless of the initial allocation of rights. It is based on the assumption that parties can bargain with zero transaction costs. If there are high transaction costs to bargaining, the Coase theorem suggests that the rights will remain with the initial rights holder.

If the initial rights to network usage data are given to individuals, then meta-information gatherers would have to negotiate with them to obtain the right to use this data. If instead, the initial rights to this data were given to meta-information gatherers, individuals would have to bargain with them to avoid having meta-information gathered. Today, technology and law contribute to a system that allocates these rights to meta-information gatherers.

Because meta-information can be gathered by many different entities, the transaction costs of individuals bargaining with meta-information gatherers is high. This problem is exacerbated by the fact that some of the gatherers may be hackers working in secret and unwilling to negotiate. Thus, the Coase theorem implies that high transaction costs will prevent individuals from efficiently bargaining to regain control over network usage information, and thus, privacy. The rights bundle will probably remain with the meta-information gatherers.

Could individuals use technology to prevent the collection of network usage data? If so, they would be re-allocating the rights to network usage data back to themselves technologically, rather than via negotiation or through the legal system. Such a technological solution is unlikely, though, because network usage data is not just a by-product of network usage, but is an integral part of network operations. Computers over which the individual has no control must generate, transmit, and store this information in order for the network to function. It is probably possible to design a network in which all network usage information has a level of indirection that makes network usage anonymous. Such a system, however, would require a massive and expensive commitment to redesign existing networks.

It appears that a private property system will not solve the privacy problem created by the collection and use of meta-information on computer networks.

2.1.3.2 Common Property Solutions

A common property system is not the same as an open access property system, although they are often confused. An open access system is a system of no property rights. No one can be excluded from using the resource, and rivalrous resources are typically overused to the point of exhaustion. A common property system, on the other hand, is a system of group-ownership and management of a resource. It requires the ability to exclude non-owners from access to the resource. Common property systems have been successfully created to reduce overuse of some natural resources (Cole, 1994). Wade lists criteria for estimating the likelihood of successful formation of common property solutions by resource users (Wade, 1987). Some of these criteria do not apply to information goods. The relevant criteria for successful common property rights creation are listed in Table 1, along with the appropriateness of each criterion to network usage information:

Criterion	Applicability tc Network Usage Data
Small, well-define resource boundaries	Ill-defined resource boundaries
High costs of privatizing property by excluding others technologically or physically	Virtually impossible to privatize these information flows
High demand for the resource	Many entities demand it, but it is somewhat non-rivalrous
Existing arrangements for managing the common property system	No systems exist now
Small number of resource owners, bound together by mutual obligations	Large number of resource owners, not bound together at all

Table 1: Criteria for Successful Common Property Regimes

Table 1 shows that most of the criteria for successful conversion to a common property regime are lacking for network information. For instance, it's not clear that individuals have any right to own network usage data collected by computers owned by other entities, even though this information is about them. Furthermore, the nature of the problem, with individuals seeking to retain privacy being in direct opposition to meta-information gatherers seeking to create valuable information, makes it very unlikely that the two groups will join together to create a common property regime that effectively manages the use of this resource. It appears that a common property regime will not solve the privacy problem created by the collection and use of meta-information on computer networks.

2.1.3.3 State Property Solutions

State property solutions involve governmental control and public administration of a resource. They are sometimes used to protect the rights of people besides the direct resource users, who are nonetheless affected by the resource's use (Bromley, 1991). This appears to be necessary for network usage data. The users of this data are the meta-information gatherers, but the individuals using the computer network are affected by this resource's use. Because of the difficulty of possessing network usage data, which is by its nature distributed and transient, governmental controls will have to consist of legal restrictions on its usage. Thus, state property solutions appear to be a possible solution to the privacy problem created by the collection and use of meta-information on computer networks.

2.2 Intertemporal Externalities

Intertemporal externalities are the second type of open-access externality. These externalities occur when over-consumption by the present generation leaves a sub-optimal amount of the resource for future generations. Examples include the present over-consumption of a non-renewable resource such as a pool of oil, and the extinction of a species due to habitat destruction.

Because digital content is endlessly renewable, it does not suffer from intertemporal externalities. Intertemporal concerns are also minimized because the useful half-life of much of the content available on networks is very short. The half-life of information has decreased as the ability to copy and distribute it has increased. Indeed, Dyson believes that the half-life of most content on networks is so short that content producers should give it away freely rather than attempt to charge for it and control its use. Giving their content away will allow them to attract customers, with whom they can establish consulting and other long-term business relationships in order to earn money (Dyson, 1994). This topic is explored in Chapter 4, **Digital Intellectual Property and Economic Pricing Models**.

2.3 Underproduction

Underproduction is the third type of open-access externality. According to Hallowell, cited in Bromley , "Property is a benefit (or income) stream, and a property right is a claim to a benefit stream that the state will agree to protect through the assignment of duty to others who may covet, or somehow interfere with, the benefit stream. Property *is not* an object but rather is a social relation that defines the property holder with respect to something of value (the benefit stream) against all others. Property is a triadic social relation involving benefit streams, rights holders, and duty bearers" (Bromley, 1991, p. 2).

External diseconomies such as underproduction occur when the marginal private benefit of a choice is less than the marginal social benefit; in this case, individuals cannot capture the entire benefit stream created by their actions, and underproduction results. This problem is called the "social welfare loss due to underproduction" (Novos & Waldman, 1984, p. 237). This problem can occur with digital content, and is examined in detail in Chapter 3, **Efficiency of Intellectual Property Rights Protection.**

2.4 Inability to Transfer Resources to Higher-Value Uses

The inability to transfer resources to higher-value uses is the fourth type of open-access externality. When property rights are unclear, it is difficult to transfer resources to higher-value uses. This is due to the inability of the higher-value user to capture the entire benefit stream. Unlike exhaustible resources, non-rivalrous digital content can always be used in higher-value uses, because another copy can be created. Unclear property rights are less significant because both the current "owner" and the consumer with a higher-valued use can obtain copies of the content simultaneously.

Some information is only valuable when the audience is limited. Transfer to higher-value uses can be blocked when access to this type of information is not restricted. For instance, a company's marketing plan for a new product is valuable when only the company's employees know it; it loses most of its value if the company's competitors obtain it. Another example is a stock analyst's report projecting rapid growth for a small company. Access to this report allows the analyst's clients to buy the company's stock before the price skyrockets. If, however, this information is made widely available, the clients won't have the opportunity to buy the stock at its current price. Thus, the ability to transfer some types of digital content to higher-value uses depends on the ability to restrict access to the content.

2.5 Protecting Intellectual Property Rights on Networks

A previous section examined several property rights regimes as possible methods to create clear property rights for meta-information, and thereby reduce the overuse externality associated with it. It concluded that neither a private nor common property regimes would successfully create clear property rights in this resource. In contrast, underproduction of digital content for networks due to the inability of rights holders to capture the benefit stream is amenable to private property solutions. Many companies and researchers are developing technical means to re-privatize digital intellectual property that is currently accessible to all.

This section describes some of the technologies being developed to protect intellectual property rights on networks. For an in-depth description of property rights management technologies under development, see Weber (1995). The economic efficiency of such systems are analyzed in Chapter 3, **Efficiency of Intellectual Property Rights Protection.**

2.5.1 Cryptography

Non-digital intellectual property requires a physical manifestation — such as a book for words, or a videotape is for images. The physical object acts as a container for the content. In fact, the container is such an intrinsic part of the content that we refer to the content by the name of its container. We don't say, "I'm going to buy a bunch of new words and ideas by my favorite author, Tom Clancy;" instead, we say, "I'm going to buy Tom Clancy's new ***book***." Rather than rent "a bunch of images assembled by Steven Spielberg," we rent a ***videotape*** of Jurassic Park. Enforcement of property rights for non-digital content is achieved by attempting to prevent the creation, distribution, and sale of illegal copies of the physical objects that contain the intellectual property.

Digital content exists, is distributed, and can be used without the physical manifestation that non-digital content requires. The user, either legitimate or not, does not need access to a book or videotape. They simply locate the bits on a network, copy them, and use them. There is no physical container for the bits. Thus, current enforcement mechanisms fail to prevent illegal duplication and use of digital intellectual property.

Cryptography is a way to create a container for bits representing digital content. "Cryptography... is the 'material' from which the walls, boundaries — and bottles — of cyberspace will be fashioned" (Barlow, 1994). Cryptographic systems use encryption to make data unusable except by authorized parties. The data is "scrambled" using mathematical methods that are extremely difficult to undo without the proper decryption "key". Access to the key is controlled; thus, the content is protected from unauthorized use.

> Encryption is the transformation of data into a form unreadable by anyone without a secret decryption key. Its purpose is to ensure privacy by keeping the information hidden from anyone for whom it is not intended, even those who can see the encrypted data. In a multi-user setting, encryption allows secure communication over an insecure channel (Fahn, 1993).

A simple digital container system would allow a content owner to broadcast an encrypted version of the content, and only give the key that decrypts the content to people who paid a fee. But this system does not offer much security for intellectual property rights, because once one person has legally unlocked the encrypted content, he or she could illegally rebroadcast the unencrypted content, enabling free riders.

Several companies have announced *cryptographic envelope*, or *cryptolope* systems that are designed to permanently protect the property rights of digital content owners. By maintaining a secure cryptolope around the content at all times, these systems ensure that the first legitimate buyer cannot simply broadcast the unencrypted version of the content to all other users. One system is from Infosafe Systems (www.infosafe.com). Another is from a Silicon Valley startup called Electronic Publishing Resources (EPR, www.epr.com). EPR calls its system *Intertrust* and its container a *DigiBox*.

> The DigiBox container is a foundation technology within the InterTrust system which provides secure content containers to package information, so that the information cannot be used, except as provided by the rules and controls. DigiBox container rules and controls specify what types of content usage are permitted, as well as the consequences of usage.
>
> Within the InterTrust system, the DigiBox containers can enforce a "distributed electronic contract," for value chain activities functioning within a distributed architecture. This unique approach underlies EPR's information metering, digital rights protection technology.
>
> Superdistribution technology allows content to be formatted once for distribution, and afterwards users can freely copy the content and pass along the copies with trusted rights protection and payment mechanisms built in (Electronic Publishing Resources, 1995).

Protecting digital content even after the first customer has purchased the right to use the content enables *superdistribution*. This concept allows unlimited broadcast of content, but ensures that payment is made each time it is used. EPR's system also includes mechanisms to automate payments via national financial clearinghouses (Smith & Weber, 1995).

Several companies are also working not on cryptolopes, but simply on electronic payment systems that will allow users to pay for goods, services, and digital content on computer networks. These companies include Digicash (www.digicash.com), and FirstVirtual (www.firstvirtual.com). These "digital cash" systems work like software versions of debit (ATM) cards. A user pays real money to a bank in exchange for increasing the balance in their digital cash account. As the user makes purchases on the network, the digital cash account is debited. These systems claim they will be so efficient that they will allow micropayments as small as fractions of cents.

2.6 Chapter Conclusion

This chapter examined whether digital content on computer networks is subject to the same types of open access externalities from which natural resources often suffer. Because consumption of digital content is usually non-rivalrous, one person's consumption of content does not diminish another's ability to also consume it. Marginal social cost equals marginal cost, so no overuse occurs. The production function for digital content is vertical. Static welfare maximization would occur if its price were zero.

Overuse of the network infrastructure can and does occur, but this paper focuses on issues related to network content and network usage. Unclear property rights in network usage data can lead to overuse, and the meta-information created from this data threatens people's privacy. Rights to network usage data lie squarely with parties that gather it. High bargaining costs may prevent the transfer of these rights to individuals via bargaining. Thus, people's privacy is at risk when they use computer networks. Private and common property systems are not appropriate methods for protecting individuals' privacy; legislation is probably required.

Digital content does not suffer from intertemporal externalities because it is endlessly renewable, and most of it has a very short useful life. Underproduction of digital content can occur, though, because content producers are unable to capture the entire benefits stream. Digital content can usually be transferred to higher-value uses, because it is non-rivalrous. This does not hold for content that is only valuable when its audience is limited.

Several companies are developing technical means to prevent unauthorized use of digital content on networks. This would allow content creators to capture the benefits stream of their content. These systems, often called cryptolopes, rely on cryptography to create a virtual container for the content; this container enables restriction of access to the container's contents.

3. Efficiency of Intellectual Property Rights Protection

Copyright is monopoly, and produces all the effects which the general voice of mankind attributes to monopoly...Monopoly is an evil... For the sake of the good we must submit to the evil; but the evil ought not to last a day longer than is necessary for the purpose of securing the good. — Lord Thomas Babington Macaulay (Plant, 1934, p. 171)

Take away from English authors their copyrights, and you would very soon take away from England her authors. — Anthony Trollope, in *Bartlett's Quotations*

In our day the conventional element in literature is elaborately disguised by a law of copyright pretending that every work of art is an invention distinctive enough to be patented — Northrop Frye, Anatomy of Criticism, *Second Essay, "Mythical Phase: Symbol as Archetype" (1957),* in *The Columbia Dictionary of Quotations, 1993*

Whether protection of digital content is economically efficient is determined by whether the benefits of protection outweigh the costs. These benefits and costs arise both from production of the digital content by firms and from utilization of it by consumers. The firms that produce digital content are often called "content producers."

The benefits of intellectual property rights protection include the private benefit captured by content producers and the social benefit of increased content production resulting from the increased incentive for production. The costs of intellectual property rights protection include the costs to content producers of securing and enforcing protection, and the social cost of lost welfare due to less utilization of the content than would occur if the content were freely available.

Intellectual property rights protection exists along a continuum. At one extreme of the continuum is a system that offers no protection to rights holders. At the other extreme is a system in which virtually all content is protected, even from what is today considered fair use. In the middle are systems that attempt to protect digital content to the extent that traditional physical information goods are protected today. This chapter examines issues of efficiency at points along this continuum. A system of no protection for digital content is examined in the context of historical arguments of the necessity of copyright and patent protection as incentives. The continuum point representing the other extreme — comprehensive intellectual property rights protection — is examined in the context of its effect on fair use of protected material. The middle area of the continuum represents some level of protection, but not complete protection. This area is analyzed via two models that examine under-utilization and underproduction effects as the level of intellectual property rights protection increases. One model is a static, neo-classical model that ignores the social welfare loss due to under-production. The other model is a dynamic model that includes this cost, but ignores the costs of securing and enforcing intellectual property rights protection. I then augment this model to include these costs.

3.1 One End of the Continuum: Is Copyright Necessary?

At one end of the intellectual property rights protection continuum is a system that offers no protection to rights holders. This could be achieved for information goods by eliminating copyright. There is a long history of argument over whether copyright is indeed necessary to ensure efficient production of information. These arguments are applicable to digital content on computer networks because copyright is the most frequently used method of seeking intellectual property rights protection for this content.

There are two common justifications of copyright. First, that copyright is necessary to create an incentive for people to create material, which in turn benefits society as a whole. Second, that copyright is necessary to protect the inherent moral rights of the creator (Erickson, 1995), (Hurt, 1966). Many European nations give explicit protection to the moral rights of creators to control how their work is used. U.S. law currently provides little support for moral rights, although it may have to change to accommodate international treaty obligations (Demac, 1994). This paper does not investigate the moral rights aspect of copyright, because it is mostly a normative question. Instead, it focuses on the incentive and social welfare aspects of intellectual property protection.

One way to analyze the necessity of copyright is to look at what would occur in situations without any copyright protection. Rather than completely drying up the supply of content, Plant observes several reasons that some level of content creation would continue even with no protection. First, many authors write without any hope of remuneration; some even pay to have their works published. They do this for various reasons, including the desire to further scientific research, for prestige, or simply to broadcast their views. Second, authors that want to profit from their writing have been able to capture some the benefits stream in situations where copyright doesn't exist and copying of original manuscripts is rampant. They exploit first mover advantages, and price their works knowing that the originals they sell will be copied. Also, errors and quality degradation introduced in the copying process become cumulative as copies are made of the copies. Thus, the value of an original is higher than that of a copy.

One example of authors making money on uncopyrightable works is English authors in the nineteenth century, who were able to secure payment from U.S. publishers even though foreign works were not copyrightable in the U.S. at that time. U.S. publishers paid English authors in order to be the first to publish a work. If a work was then printed by another publisher, the original publisher would then come out with a very low-priced "fighting edition," priced below the second publisher's cost; this ensured that the second publisher made no money on that work. The use of first mover advantages and retribution enabled U.S. publishers to profit and English authors to receive payment for their work (Plant, 1934).

Hurt examines the issue of what would get published with and without protection, based on the ability to recoup investment, and how this affects social welfare. He lists three broad categories of works: those that would be published even without copyright protection; those that would not be published even with copyright protection, and those that would be published only with copyright protection.

The first category consists of works that will cover their costs even without protection. Thus, copyright does not lead to the publishing of these works; rather, it artificially raises the price of these works.

The second category consists of submarginal works that would not cover their costs, even with protection. Copyright alone for these works will not induce publication. These works are sometimes published at a loss, however, using the profits from publications in the first category. This publication can be construed as a misallocation of resources.

The third category consists of works that can only cover their costs with copyright protection. Without protection, others will republish the work and drive down prices, leading to a gap between the social welfare created by the work and the private benefit captured by its creators. With protection, the creators are able to capture the benefits stream themselves.

Thus, the impact of copyright on social welfare consists of the negative effect of monopoly pricing for works that would be published anyway, the negative effect of the possible publication of submarginal works, and the positive effect of the publication of works that would not be published without copyright protection (Hurt, 1966).

Another social cost is the effort put into creating substitute works (Kitch, 1980). Some consumers will be unwilling to pay the monopoly price for a copyrighted work. Other producers may respond to this by creating similar, substitute works and offering them at a price that is lower than the monopoly price of the original work, but higher than the marginal cost of producing the original work. Because information goods are typically expensive to create but inexpensive to reproduce, the cost of creating the substitute good will negatively impact social welfare. This is offset to the extent that consumers value variety in these works.

It is often argued that the benefits of greater production of intellectual property induced by copyright protection outweigh the costs of such protection. This argument is very similar to the incentive argument put forth for patent protection of inventions. Greer analyzes this argument for patents. Proponents of patent protection argue that not just the gross, but also the net social benefits provided by patent-dependent inventions (i.e., inventions that would not have occurred without patent protection) exceed the social costs of such protection. But many inventions are not dependent on patent protection; they would be invented even if no patent protection was available. These inventions also generate benefits, but these benefits cannot be attributed to the patent system. However, many of these inventions are nonetheless patented, and therefore, the costs of patent protection for these non-patent dependent inventions (the cost of patenting, the resulting monopoly price of the good, etc.) must be taken into account when analyzing the efficiency of the patent system (Greer, 1992). This is analogous to the welfare equation that Hurt describes for copyright-dependent and non-copyright-dependent works.

One often-overlooked aspect of patent protection inefficiency is costs created by goods that should not be eligible for patent protection, but receive it anyway. This seems to occur frequently with computer- and software-related patents. The most noted example is a patent issued to Compton's NewMedia, a company that produces a CD-ROM-based multimedia encyclopedia. In 1992, Compton's was granted a patent that essentially said they invented hypertext navigation, which is the basic user interface for computer-based multimedia titles. Compton's did not invent this interface; in fact, it had been used extensively for several years in popular programs such as Apple's HyperCard. Compton's aggressively attempted to force other software companies to pay it a large royalty for programs that "infringed" on its patent. These companies, threatened with paying a hefty royalty to use a fundamental technique that they believed was public domain, forced the U.S. Patent and Trademark Office to reconsider the patent. The Patent and Trademark Office held a series of public hearings, and eventually, all of Compton's patent claims were rejected and the patent was annulled (Luskin, 1994).

There have been other computer- and software-related patents that were probably equally invalid, yet were not overturned because they didn't represent as fundamental a technique as the Compton's patent did, and so did not cause the same level of uproar. One example is the Grid Systems "hinge" patent. Grid Systems was one of the pioneers in developing laptop computers. In the early 1980's, Grid received a patent for using a hinge to allow the laptop's screen to fold down and close on top of the computer's keyboard. This "clamshell" design ended up being the most popular laptop computer design, and most, if not all, companies, implemented it with the obvious mechanism, a hinge. When Grid was bought by Tandy, the large company that owns Radio Shack, Tandy began to aggressively enforce this patent, and received substantial license fees from many laptop manufacturers.

Patent law requires that a work be novel and non-obvious to receive patent protection. The use of a hinge to close a case probably fails these two tests in the eyes of most people, since hinges have been used for hundreds of years to close doors and lids. Tandy was able to receive payment because the issue was apparently not viewed as fundamental enough by most other companies to contest. It was simply easier to pay Tandy than to contest the validity of the patent.

An analogous inefficiency in the protection of digital content is the protection of intellectual property that is freely available elsewhere. This could occur either via copyright, or more likely, by using a technology such as cryptolopes. One possible example would be the encrypting and sale of government reports and data, which are not copyrighted and are often available free from government Web sites. This already occurs with freely-available non-digital government information, such as the property tax homestead exemption form that disreputable businesses offer to homeowners for $20 or more, even though these forms are available free from county assessors. It is likely that this will occur in the digital domain as well.

Because the patent system does have some inefficiencies, it is interesting to analyze what the effect on innovation would be if there were no patent protection available. Evidence shows that much invention and innovation would occur even without patent protection. Greer cites four reasons for this:

1. Innovations can often be kept secret;
2. Many firms invest in research and development in order to maintain or gain competitiveness, rather than to develop unique, patentable products;

3. Other sources of market power such as barriers to entry, first mover advantages, and high concentration protect prices even when imitation products are available;

4. Some companies over-invest in research and development, apparently on the belief that it will lead to windfall developments (Greer, 1992).

Some of these methods may be able to help rights holders capture the benefits of unprotected digital content on computer networks. The first protection, secrecy, is obviously not applicable. Keeping the content secret would make it useless, since it is not transformed into a product, but rather, is the product itself.

The second protection, rapid innovation, is very applicable to digital content. Much information has a very short half-life of usefulness, and becomes obsolete before protection is obtained. Dyson believes that most information has such a short useful life that it will be available free of charge, or nearly so. Rather than make money selling information, businesses will give away information as advertising to attract customers who then subscribe to their service, hire them as consultants, or can be engaged in a long-term, business relationship (Dyson, 1994). In order for free content to entice subscriptions to a future content or service stream, however, proper attribution of the original content is required (Schlachter, 1995).

The third protection, other sources of market power, is somewhat applicable. Barriers to entry exist for creating content; that is, creating valuable digital content is at least as difficult and expensive as creating valuable printed or video content. But barriers to distribution of content are almost non-existent; virtually anyone can place digital content on networks such as the Internet. The World Wide Web portion of the Internet is currently organized in a flat, rather than hierarchical fashion. Most Web sites seem to be equally accessible and, to some extent, equally credible. Dyson claims that this will rapidly change. Cyberspace is not infinite, but rather is limited by the amount of human attention that can be devoted to it. "Does a place in cyberspace that no one ever visits really exist?" (Dyson, 1994, p. 19). Thus, independent rating services and other organizational services will develop to pass judgment on the value of content at various locations. "The new wave is not value-added; it's garbage-subtracted." (Dyson, 1994, p. 21). This is already occurring on the World Wide Web. A search engine called Magellan (www.mckinley.com) now offers ratings of Web sites retrieved by a user's search query. As rating and other organizational systems proliferate, more barriers to entry will exist for distribution of digital content, and other forms of market power, such as brand names, high concentration, and first mover advantages, will become more useful.

The fourth protection against insufficient innovation, over-investment due to (over-)optimism, seems to be occurring already. Internet-related common stocks, such as Netscape, Quarterdeck, and Ascend Communications, were among the biggest gainers on Wall Street in 1995, and many analysts believe that these stocks are greatly overpriced.

3.1.1 So Is Copyright Necessary?

There are many points to both sides of the question of whether copyright is necessary. History shows that without any copyright protection, books are still published and authors are still paid. But copyright allows books to be published that would not otherwise recoup enough investment to be published. This increases social welfare. It also leads to the publication of books that are not able to recoup their investment, even with copyright protection, and raises the price of books that would be published even without protection. These factors diminish social welfare. Efforts put into creating substitute works to satisfy consumers unwilling to pay the monopoly price of a copyrighted good also diminish social welfare, because an additional copy of the original digital work can be created for very little cost. Some goods that are not eligible for copyright protection may be protected technologically, which would also reduce social welfare.

Without copyright, content creators could rely to some extent on rapid innovation to attract paying subscribers. Some information has such a short useful life that it is given away freely to cultivate other business relationships. As the quality of content available on networks becomes more differentiable, forms of market power such as brand names may increase firms' ability to charge for their content.

With very little empirical research available, it is difficult to determine whether copyright is necessary to maximize social welfare. The question may become moot regarding digital content, though. While copyright is currently the law under which rights holders obtain payment for use of their information good, contracts may replace copyright as the preferred protection mechanism if technology is able to lower the transaction costs of contracting. This would enable rights holders to protect their works directly, without government assistance via copyright.

Contracts are a frequently-used system to ensure remuneration for the use of goods. Contracts are not feasible for many goods, especially information goods, though, because of the transaction costs involved. For instance, rather than selling a copy of a book to an individual and allowing him or her to read it freely, the publisher could enter into a contract with the individual that charged the reader each time he or she read the book. Obviously, the cost of stationing someone in the buyer's home to count readings is prohibitive (Hardy, 1995).

A system called "header contracts" might enable contracting for electronic transactions by reducing the transaction costs of the offer and acceptance elements of the contract. Encryption and metering technology, such as EPR's InterTrust system, can enforce the contract terms by tracking use, and making payments for that use. This would complete the consideration element of the contract.

In such a system, information goods would be packaged into software "objects" on computer networks. Each object would have a permissions header, which specifies the terms of usage for that object. The header also specifies what type of content the object contains; for instance, whether the content is a research report or a poem. It also specifies the topic, keywords, and perhaps contains an abstract of the content. At the behest of a person, software agents, often called "knowbots," would search the network for content that satisfies both the content query and the economic terms the person is willing to meet. The economic terms can include more than just the price. For instance, the person may require the right to quote from the material in their own work; some objects might allow this, and some might not. When the knowbot finds an object that meets its content and contract terms, a contract is created between the knowbot and the content object (Perritt, 1994).

Samuelson believes that header contracts might supplant copyright for protecting digital works. "The need for copyright law itself would become questionable if one could bind every user to limitations on access to every information product available in the market" (Samuelson, 1994, p. 4). This could have a large impact on fair use of copyright material, because "Licenses and other contracts cannot transform noninfringing uses (such as fair uses) into infringements; they can, however, make such uses violations of the terms and conditions of the agreements..." (Working Group on Intellectual Property Rights, 1995, p. 50). This aspect is examined the next section.

3.2 The Other End of the Continuum: The Effect of Intellectual Property Rights Protection on Fair Use

One end of the intellectual property rights protection continuum is a system that provides no protection. The other end of is a system that provides protection virtually anytime content is accessed. A technological system of cryptolopes, knowbots, and header contracts could make such a system a reality. Such a system could make it impossible to even browse through protected content without first paying the rights holder. This system would certainly create strong incentives for content production. It would also, however, restrict people's ability to use the content. The current system created by copyright law is not this restrictive. The key doctrine that keeps copyright law somewhere in the middle of the protection continuum is *fair use.*

Understanding fair use requires understanding the motivation behind copyright and patent law. These laws stem from the U.S. Constitution, but the framers did not give Congress the right to create these laws to ensure that creators received remuneration. Rather, copyright and patent were designed to ensure the scientific and artistic progress of society. Article I, Section 8 of the Constitution states:

> The Congress shall have power... to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.

Justice Sandra Day O'Conner, in *Feist Publications, Inc. v. Rural Telephone Service Co.*, 499 US 340, 349(1991), reiterates this viewpoint:

> The primary objective of copyright is not to reward the labor of authors, but "[t]o promote the Progress of Science and useful Arts." To this end, copyright assures authors the right to their original expression, but encourages others to build freely upon the ideas and information conveyed by a work. This result is neither unfair nor unfortunate. It is the means by which copyright advances the progress of science and art (American Association of Law Libraries, 1995).

Fair use is the key copyright doctrine that protects people's ability to use copyrighted material to promote "science and useful arts." "Fair use is the means by which researchers learn and in turn write for the benefit of society. It is the fuel that drives the engine of progress envisioned in the Constitution..." (Oakley, 1993). Fair use creates benefits for all of society by furthering scientific and technological research, both of which can help raise productivity, and thus, living standards. It also increases the efficiency of information flows. For instance, teachers are able to summarize and quote from scholarly works and present these summaries to students; this is more efficient than having each student do this research themselves.

A rights holder, as a member of society, benefits from the social benefit created by fair use of his or her copyrighted material. Obviously, as just one person out of several hundred million, the rights holder's share of the social benefit is very small. Because the total social benefits created by fair use exceed the portion captured by the rights holder, fair use is a quasi-public good.

Because of the importance of fair use for scientific, technical, and artistic progress, the losses to society are potentially very high if fair use is impeded.

The Copyright Act of 1976 codified Fair Use in Section 107 (Association of American Universities, 1994). Four factors determine whether a particular use of copyrighted material constitutes fair use or a copyright violation: the purpose of the use, how much of the material was used, the nature of the use, and the effect on the market for the work. Judicially, fair use is determined on a case-by-base basis (Olson, 1996). But generally, fair use includes using copyrighted material for criticism, scholarship, research, and teaching (American Association of Law Libraries, 1995). In addition to fair use, existing copyright law gives the public the right to freely view and read copyrighted material. For instance, once an author publishes a book, he or she cannot control who reads it. Some courts have recently supported the notion that the right of exclusive reproduction given to copyright owners also controls temporary reproduction of digital works in the memory of a computer (Litman, 1995). The federal government's Working Group on Intellectual Property Rights sub-committee of the Information Policy Committee, Information Infrastructure Task Force, issued an influential White Paper that supported this concept. The White Paper recommendations are heavily weighted toward more extensive copyright protection of digital content, at the expense of public use of such content (Larson, 1995). The White Paper proposes creating a new exclusive right for copyright holders, that of transmission. Transmitting a piece of digital content from one computer to another would be considered analogous to photocopying a book, and thus would constitute a copyright infringement (Lyman, 1995). The problem that this creates for fair use is that in order to view digital content residing on a network, the content must be transmitted from its host computer to the end user's computer. Thus, even browsing a copyrighted work without the copyright owner's permission would be a violation of the copyright. If enforced, such legislation could sharply reduce people's ability to fairly use copyrighted material because a researcher or other potential fair user would have to either pay to view the content, or seek and receive explicit permission from the copyright owner to use the material.

In addition to legislative changes, new technologies such as cryptolopes will allow precise metering of information usage, and enable rights holders to charge a fee every time the information is used. This is equivalent to a book publisher being able to charge a fee every time a book is read by anyone anywhere in the world. Technological changes that affect the public's ability to use digital content will occur more rapidly than legal changes. The White Paper noted the possibility that new technology will reduce the scope of fair use:

> Finally, it may be that technological means of tracking transactions and licensing will lead to reduced application and scope of the fair use doctrine. Thus, one sees in *American Geophysical Union v. Texaco Inc.*,[262] a court establishing liability for the unauthorized photocopying of journal articles based in part on the court's perception that obtaining a license for the right to make photocopies via the Copyright Clearance Center was not unreasonably burdensome. The court also speculated that should the proprietors fail to establish a licensing system for the use in

question, then the balance might shift in favor of a finding of fair use (Working Group on Intellectual Property Rights, 1995, p. 82).

Samuelson also notes that "technological protections of digital works in networked environments may spell the end of fair use. ...Encryption of the work may also make it impossible to borrow any part of someone else's work without paying for it" (Samuelson, 1995, p. 6).

The law may support the technology-induced shift from copyright governance of fair use to contractual governance. There are two views of copyright law: copyright as property and copyright as liability. The copyright as property view sees copyright as a way to establish property rights in otherwise-intangible goods. The copyright as liability view sees copyright as a way to specify how parties are allowed to use intangible goods. Under the copyright as property view, parties can make virtually any contract concerning copyrighted material. Such contracts can limit fair use. Under the copyright as liability view, federal law preempts parties' ability to make contracts that limit fair use (Hardy, 1995). In general, the White Paper supports a shift toward the more restrictive copyright as property view. It favors the development of technological means to enable protection of property rights in digital content, and contains recommendations for specific provisions that would support such technology. An example is the recommendation that the development of devices that circumvent cryptolopes or other protection technology be made illegal, and punishable as a felony.

To the extent that technological or legal means hinder current fair use practices, there could be a loss of social benefit. Because this social benefit is a key element in driving technical and artistic progress, the possible ramifications of this loss are substantial.

Fellner analyzes the costs of generating societal progress, and finds three factors: the costs of producing new knowledge, the cost of distributing this knowledge to people so that they can employ it, and the costs of putting the new knowledge to use. He argues that "...*practically all* long-run increase in output per man-hour (or possibly more than this) involves invention and/or additional knowledge-distribution..." (Fellner, 1970, pp. 8-9). Reduction of fair use will increase the cost of distributing knowledge. It will also have a disproportionate impact on research, which benefits greatly from fair use, and thus has the potential to slow the development of new inventions.

A topic for further research is the development of a model to quantify the social welfare implications of the current system of fair use, estimate the impact of possible changes to fair use policies or practices, and test the model empirically, perhaps by looking at technical and artistic progress in other nations with different notions of fair use.

3.3 Moving Along The Continuum: The Effects of Increased Intellectual Property Rights Protection

Adding digital content to a network increases the value of that network to society. Without proper incentives, underproduction occurs. Therefore, incentives to ensure content production are important. Enabling people to apply fair use to that content also benefits society. Therefore, an intellectual property rights protection policy that supports some level of fair use is also important. Without this, under-utilization will probably occur. Therefore, efficient intellectual property rights protection probably lies somewhere in the middle of the protection continuum, between no protection and absolute protection. This section examines the effect on underproduction and under-utilization of increasing levels of intellectual property rights protection.

Some authors seek and receive non-monetary compensation for their content; for instance, researchers receive feedback from peers, as well as prestige among them. For these authors, the marginal social benefit is not greater than the marginal private benefit, and the socially optimal level of production occurs. But the inability to protect copyrighted material on networks from unauthorized duplication and use means that in many cases, the marginal private benefit of adding content is less than the marginal social benefit. The inability to capture benefit streams is a major deterrent to placing content on networks such as the Internet.

As the ability to protect intellectual property on networks increases, creators have more incentive to produce it. But less of it may be consumed, because some consumers will be unable to make illegal copies (pirate it), and are unwilling to pay the above-marginal-cost price for a legitimate copy. Judging whether increased intellectual property protection produces economically efficient incentives comes down to determining whether the decrease in social welfare loss due to less underproduction is greater than the increase in social welfare loss due to greater under-utilization. This can be analyzed via a static neo-classical model, or a dynamic model.

3.3.1 Under-utilization and Underproduction in a Neo-classical Model

Jussawalla applies a neo-classical approach and argues that the social welfare loss due to greater under-utilization shows that intellectual property rights protection should be reduced for digital content, not increased. His argument is that Pareto optimality can only be achieved if information that has a zero marginal cost of reproduction is available freely. He further argues that widespread piracy of U.S.-produced software in countries such as Taiwan has not deterred further production of such goods, and therefore, the inability of producers to capture the benefit stream from digital intellectual property does not have a negative impact on their willingness to continue creating it. His last point is that the product life cycle of much digital content is very short, so protecting it via copyright lowers people's productivity, since they will be unable to obtain use of it during its limited useful life (Jussawalla, 1992).

This analysis has several flaws. One flaw is his notion that widespread piracy of software in certain countries has not acted as a disincentive to further creation of software. While this is true, it is true mostly because the possibility of selling English-language software into non-English-speaking markets that are tiny compared with the U.S. market was not an incentive to software creation in the

U.S. in the first place. Having worked as a professional computer programmer in Silicon Valley for 10 years, I can state that U.S. software companies do not develop English-language software with hopes of gaining users, either legitimate or pirate, in small, non-English-speaking countries. U.S. software development is geared mostly toward the U.S. market. Popular programs are often "internationalized" for various European languages, and a few very popular programs are rewritten to work with non-Roman languages such as Chinese, Japanese, and Korean. A more important flaw in Jussawalla's argument is that his analysis is static, and seems to ignore the social welfare loss due to underproduction.

3.3.2 Under-utilization and Underproduction in a Dynamic Model

A dynamic analysis of missing property rights protection takes into account not just under-utilization, but also the effect on future production of intellectual property. Novos and Waldman's dynamic model explores both under-utilization and underproduction (Novos & Waldman, 1984).

Novos and Waldman describe two components of social welfare loss due to under-utilization for partially non-excludable goods such as computer software. Both components exist because of the market power of the producer, who is able to charge a price greater than the marginal cost of production. One component is the loss that occurs when consumers who would be willing to pay the marginal cost of production, but not the price, do not consume a good. The second component is the loss that occurs when some consumers expend more resources obtaining copies of the good by borrowing a legitimate copy and pirating it than the producer would expend to produce another unit. For example, suppose a monopolist is able to produce another unit of a good for $1, but charges $5 for it. Consumer *A* is willing to pay $4 for the good, and consumer *B* is willing to pay $2. Consumer *A* consumes the good, but does so by expending $3 creating a pirate copy. Consumer *B* doesn't consume the good. One component of social welfare loss is due to consumer *B* not consuming a good for which he is willing to pay the marginal price of production. The other component is due to consumer *A* expending $3 of resources to obtain a unit of the good, when the monopolist would have only expended $1 to produce another unit.

It seems intuitive that as intellectual property protection increases, resulting in higher expenditures to obtain pirate copies, the social welfare loss due to under-utilization will increase because fewer consumers will be willing to pay the higher price of a pirate copy. This is in fact what Jussawalla's model demonstrates. But Novos and Waldman's model shows that as intellectual property protection increases, the social welfare loss due to under-utilization does not increase.

Their conclusion differs because they account for the costs consumers expend in illegally obtaining a copy of the good. The monopolist is the *primary* market for obtaining the good. The market where consumers borrow original versions of the good and illegally copying them is the *secondary* market. The monopolist has market power, and charges above-marginal cost for the good. Thus, some consumers, such as consumer *A*, expend more resources to obtain a copy via the secondary market than the monopolist spends to create another copy for the primary market. As intellectual property protection increases, the cost of the good in the secondary market increases. This occurs for several reasons, including extra time spent finding an unprotected copy, and the increased risk of being caught infringing. As a result of this price increase, some secondary market consumers switch to the primary market. The copy of the good they obtain via the primary market is created using fewer resources than a unit of the good obtained via the secondary market. For instance, suppose increased intellectual property protection raises the price of a pirate copy from $3 to $4. Consumer *A* will now switch from the secondary market to the primary market. Only $1 of resources will be consumed to create another legitimate copy of the good, rather than $4 to create another pirate copy. This effect leads to the finding that the social welfare loss due to under-utilization does not increase after an increase in intellectual property protection.

Novos and Waldman's model analyzes underproduction as well as under-utilization. It demonstrates that there always exists a social welfare loss due to underproduction. It further claims that under certain circumstances, this social welfare loss decreases as intellectual property protection is increased; this finding agrees with claims of previous authors. But the model shows that if the cost of obtaining a reproduction is a decreasing function, an increase in intellectual property protection can shift enough consumption from the primary to the secondary market to increase the social welfare loss due to underproduction.

For traditional types of intellectual property, such as books, the cost of obtaining a reproduction is usually nondecreasing. Whether the secondary market consumer copies the original book or a copy of it, that consumer incurs the costs of obtaining the book and reproducing it. A large-scale operation that creates many copies of the book incurs the same reproduction cost for each copy. Thus, even large-scale book piracy operations have a uniform density function for reproduction costs. For these goods, increased intellectual property protection will reduce the social welfare loss due to underproduction.

Unlike traditional types of intellectual property, digital intellectual property on networks can result in a decreasing cost of obtaining a reproduction. Furthermore, copies of the original are exact duplicates. Therefore, in contrast to physical content such as a book, a copy of a copy of digital content has the same quality as the original. As these copies proliferate across the network, it becomes easier for secondary market consumers to find the content. Assuming that all consumers have the same cost of creating a new copy, the widespread proliferation of exact copies lowers consumers' cost in the secondary market. In the example, consumer *A*'s cost of creating a pirate copy of a digital work decreases as copies propagate across the network, because he spends less time searching for an "original" to copy. To the extent that the marginal cost of creating a pirate copy remains above the monopolist's marginal cost of production, Novos and Waldman's model implies that increased intellectual property protection of digital content on computer networks will *increase* the social welfare loss due to underproduction.

3.3.3 Augmenting the Dynamic Model

A key factor missing from the Novos and Waldman model is the expenditures of monopolist producers to protect their intellectual property. This section describes Novos and Waldman's model in detail, then augments it to include these expenditures. The augmented model is then used to analyze the effect on social welfare of increased intellectual property protection for digital content.

The market consists of a partially nonexcludable good, M, produced by a monopolist. The following equation shows the monopolist's total cost of producing x units of good M with quality Q:

$$TC(x,Q) = F(Q) + cx \tag{1}$$

where $F(Q)$ is the fixed cost of production, and cx is the variable cost of production. Only the quality of the good affects the monopolist's fixed costs; only the number of units produced affect the monopolist's variable costs. The model concerns quality because any quantity of the information good can be produced.

Consumers can obtain a unit of M one of two ways: they can purchase M from the monopolist for price P (the primary market), or borrow an existing unit of M

and copy it (the secondary market). The monopolist's marginal cost of production is c. Each individual's cost of finding an original to copy varies from 0 to Z, and is denoted by z_i for individual i; the continuously differentiable, non-zero density function $g(\cdot)$ describes this distribution of costs. The term N denotes the number of consumers, and is equivalent to $\int_0^Z g(z)dz$. The cost to an individual of creating a copy is $c + z(1+H)$, where the non-negative number H describes the level of copyright protection.

The quality of the unit M determines the value the consumer acquires via its consumption; this quality is Q_i for individual i. Each consumer values quality identically; this valuation is denoted by v. The profit function for a consumer is as follows:

$$\pi_i = vQ_i - e_i \tag{2}$$

where e_i represents the costs to the consumer of acquiring the good.

Assume that the monopolist is a social-welfare-maximizing government that sells a unit of M for its marginal cost, and that all consumers obtain M via the primary market. Net social welfare is then described by equation (3):

$$\begin{aligned} NSW_1 &= \int_0^Z vQg(z)dz - F(Q) - c\int_0^Z g(z)dz \\ &= vQN - F(Q) - cN \end{aligned} \tag{3}$$

Net social welfare is then maximized at Q^* when:

$$\int_{0}^{Z} vg(z_i)dz_i - F'(Q) = 0 \tag{4}$$

Now assume that the monopolist charges a price higher than marginal cost. Some consumers no longer purchase *M* in the primary market; instead, they obtain it via the secondary market. The price of *M* in the secondary market is less than the price the monopolist charges, but the resources expended obtaining the good exceed the marginal cost. The quality of the good in the secondary market is identical to the original good because duplicates are exact copies. Consumers' decision to buy or copy depends only on the relative cost of the good in the two markets. Consumers will copy, rather than purchase, when copying costs less than the price charged by the monopolist, *P*:

$$c + z_i(1+H) < P, \text{ or } z_i < (P-c)/(1+H) \tag{5}$$

For convenience, let Z_2 specify the point at which copying costs equal the price charged by the monopolist, $(P-c)/(1+H)$. Net social welfare is now described by the following equation:

$$NSW_2 = \int_0^{Z_2} [vQ - z(1+H)]g(z)dz + \int_{Z_2}^{Z} vQg(z)dz$$
$$- F(Q) - c\int_0^{Z} g(z)dz \tag{6}$$

Equation (6) has four terms. The first term is the social welfare, net of search costs, gained by consumers who copy the good. The second term is the gross social welfare gained by consumers who purchase the good. The third term is the fixed cost of producing the good. The fourth term is the variable cost of producing the good in either the primary or secondary market.

Net social welfare is maximized in terms of product quality when:

$$\int_0^{Z_2} vg(z)dz + \int_{Z_2}^{Z} vg(z)dz - F'(Q^*) = 0, \text{ or} \quad (7)$$
$$\int_0^{Z} vg(z)dz - F'(Q^*) = 0$$

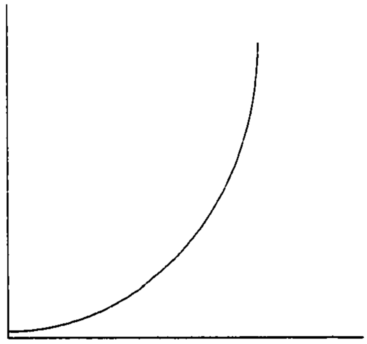
The monopolist, however, is only concerned with consumers who purchase the good; net social welfare gained by consumers who copy is an externality to the monopolist, albeit a positive externality for society. Thus, the monopolist's maximization function ignores consumers who copy:

$$\int_{Z_2}^{Z} vg(z)dz - F'(Q_2^M) = 0 \quad (8)$$

Rearranging (7) and (8) yields the following maximization conditions:

$$\int_0^{Z} vg(z)dz = F'(Q^*) \text{ to maximize social welfare at } Q^* \quad (9)$$
$$\int_{Z_2}^{Z} vg(z)dz = F'(Q_2^M) \text{ to maximize social welfare at } Q^M$$

Equation (9) states that the rate of change of fixed costs is lower at the monopolist's point of maximization than at the socially optimal point. Assume that the fixed costs are higher for higher-quality goods; a graph of this looks like the following:



The rate of change of fixed costs is lower the lower the quality of good desired. Therefore, it holds that $Q_2^M < Q^*$ for all H. This shows that the quality of the good produced by the monopolist is less than the socially optimal quality. This implies that when copying occurs, so does underproduction.

The term H does not impact the monopolist's cost function in the original model. One interpretation that meets this criterion is that H represents the level of effort by society, rather than the monopolist, to enforce existing copyright laws. Now introduce the cost of enforcing property rights to the model by adding a new variable, and analyze the effects. This cost represents expenditures made directly by the monopolist to protect their intellectual property — for instance, the use of technology such as a cryptolope in their content-delivery system. This cost is another variable cost of production, and the total cost becomes:

$$TC(x,Q) = F(Q) + x(c+h) \tag{10}$$

Assume also that the monopolist's expenditure to protect their intellectual property, *h*, leads to a corresponding, identical expenditure by a copier to defeat the protection. This expenditure could be for a software program that defeats the cryptolope, or the extra time necessary to find an unprotected original. Again, only consumers for whom copying is more expensive than purchasing will purchase; that is, if $c + h + z_i(1+H) < P$, or $z_i < (P-c-h)/(1+H)$ for a particular consumer, that consumer will copy. For convenience, let Z_1 denote $(P-c-h)/(1+H)$. Net social welfare is now given by the following equation:

$$\begin{aligned} NSW_3 = &\int_0^{Z_1}(vQ - z(1+H))g(z)dz + \int_{Z_1}^{Z} vQg(z)dz - F(Q) \\ &- c\int_0^{Z} g(z)dz - 2h\int_0^{Z_1} g(z)dz - h\int_{Z_1}^{Z} g(z)dz \end{aligned} \qquad (11)$$

This equation has six terms. The first term is the welfare, net of search costs, gained by consumers who copy. The second term is the gross welfare gained by consumers who purchase. The third term is the cost of producing all units of *M*. The fourth term is the variable cost of producing the good in either the primary or secondary market. The fifth term is the cost of creating and overcoming technological copyright protection for goods in the secondary market. The sixth term is the cost of creating technological copyright protection in the primary market. Equation (11) shows that due to expenditures for technological intellectual property rights protection, *h*, net social welfare, NSW_3, is lower than without technological protection. As *h* increases, however, the loss of social welfare decreases because consumers switch from the secondary to the primary market. This causes the fifth term of NSW_3 to decrease and the sixth term to increase, which increases net social welfare.

The monopolist's maximization problem is now:

$$\int_{Z_1}^{Z} vg(z)dz - F'(Q_1^M) = 0 \tag{12}$$

while social welfare is still maximized when:

$$\int_{0}^{Z} vg(z)dz = F'(Q^*) \tag{13}$$

Increasing h raises the cost of the good in the secondary market. Thus, fewer consumers will copy, and more will buy in the primary market. Therefore, $Z_1 < Z_2$. Because:

$$\int_{Z_1}^{Z} vg(z)dz - F'(Q_1^M) = \int_{Z_2}^{Z} vg(z)dz - F'(Q_2^M) = 0 \tag{14}$$

it follows that $Q_1^M > Q_2^M$. This shows that as h increases, the quality of the good M produced by the monopolist increases toward the socially optimal quality, increasing social welfare. Thus, there are two factors affecting net social welfare as technological protection increases. The cost of technological intellectual property rights protection decreases social welfare, while the resulting incentive to produce greater quality output increases social welfare.

3.3.4 Other Effects

Johnson develops a dynamic model of copying based on models of product differentiation and optimal patents. Unlike Novos and Waldman, this model allows consumers to have different tastes.

The model shows that copying increases consumer surplus by increasing utilization. On the other hand, it reduces content producers' incentive to create new works. The more consumers value a variety of works, the greater the negative impact of copying on social welfare. Thus, in the long run, the decrease in social welfare due to underproduction is greater the greater consumers' desire for product variety (Johnson, 1985).

3.4 Chapter Conclusion

Intellectual property rights protection exists along a continuum, from one extreme that offers no protection for rights holders, to another extreme in which virtually all content is protected from unauthorized use. This chapter examined issues of efficiency at points along this continuum. The no protection extreme was examined in the context of the necessity of copyright, a question with a long history of debate. In situations without any copyright protection, authors continue to write and publishers continue to publish at least some works. They exploit other advantages, such as first mover advantages, to receive payment. Copyright creates costs as well as benefits. Some sub-marginal books that would not be published without copyright protection get published. In addition, copyright creates a monopoly and leads to prices that exceed marginal cost.

Resources are wasted creating substitute works. On the other hand, some valuable works would not be published without copyright protection.

These findings are similar to findings on the necessity of patents. Many patented inventions would have been created without patent protection, but some valuable inventions would not have been created. Some alternatives to patent protection that inventors can utilize, such as rapid innovation, are also available to content creators in the absence of legal or technical copyright protection.

The question of the necessity of copyright as an incentive may become moot as technological systems enable rights holders to protect their works. These systems might be able to enforce contracts regarding use of the content. Header contracts could enable knowbots to negotiate these contracts; cryptolopes could enforce the contract provisions. If such systems become prevalent, a possible new cause of social welfare loss is the technological protection and subsequent pricing of works that are not copyrightable, such as government data.

At the other end of the intellectual property rights protection continuum is a system of absolute protection. Such a system is becoming possible, both technically and legally. Every use of digital content would be metered and priced. This would create a more restrictive environment for the use of information than exists today in the U.S. These developments threaten the fair use doctrine, and could have a deleterious effect on scientific and artistic progress. This topic could benefit from the development of a model to estimate the social benefits created by the current fair use system.

Between the two extremes of no protection and absolute protection are systems that offer some, but not complete, protection of intellectual property rights. It is generally believed that, as protection is increased, incentives to produce content increase, and the ability to use it decreases. Thus, increased protection results in lower social welfare loss due to underproduction, but greater social welfare loss due to under-utilization. This tradeoff was analyzed through two models, a static model, and a dynamic model.

The static model confirms that social welfare loss due to under-utilization exists as a result of intellectual property rights protection. This model, however, ignores the long-run effect of rights protection on the incentive to create content.

The dynamic model takes both under-utilization and underproduction into account. The model shows that as intellectual property protection is increased, the social welfare loss due to under-utilization does not increase. This is in contrast to previous authors' findings. The model shows that, in most cases, the social welfare loss due to underproduction decreases as intellectual property protection is increased. Many of the conditions under which this social loss increases are, however, found in markets for digital content on computer networks.

This model was augmented to include the expenditures of monopolist producers to protect their intellectual property. The augmented model shows that there are two opposing factors affecting net social welfare as these expenditures increase. One factor is the resources spent on technological protection, which decrease social welfare. The other factor is the increased production incentive, which increases social welfare.

4. Digital Intellectual Property and Economic Pricing Models

The real price of everything, what everything really costs to the man who wants to acquire it, is the toil and trouble of acquiring it. — Adam Smith, The Wealth of Nations, vol. 1, book 1. Chapter 5, in *The Columbia Dictionary of Quotations, 1993*

Nowadays people know the price of everything and the value of nothing. — Oscar Wilde, in *The Columbia Dictionary of Quotations, 1993*

The unique nature of digital intellectual property affects not only property rights, incentives, and efficiency, but also affects prices of these goods. This chapter examines three pricing issues: the price of information goods, transaction costs associated with information goods, and the ability to create new types of value.

Due to its non-rivalrous nature and ease of distribution, information goods may cause substantial changes to existing pricing models. For instance, information that used to be priced may become freely available once it is in digital form. Information delivery that is now subsidized could be charged for instead. Indirect payments to consumers to receive advertising could be replaced by direct payments. The nature of digital information could also create ample opportunities to practice price discrimination.

The ease with which digital information is distributed could lower associated transaction costs. This could allow buyers and sellers to meet directly, without intermediaries, which could result in lower prices to consumers and higher profits to firms. On the other hand, the complexity and abundance of digital content may necessitate even more intermediaries than exist in traditional markets.

The nature of digital content also changes the types of value it creates. Goods that are valuable now, such as content, will lose value if their prices drop. Creators of these goods will have to find new ways to earn a return on their content production investment. At the same time, opportunities will exist to create new value, such as meta-information.

4.1 The Price of Digital Information Goods

Two very different futures are being predicted for digital intellectual property on computer networks. One vision predicts that because it is difficult to protect rights in digital content and very easy to distribute it, content producers will not be able to receive payment for their work, and virtually all digital content will be free. The other vision predicts that rights in any "valuable" content will be protected by technology such as cryptolopes, and the content will be priced.

A mixture of these two visions is likely. Some content will be protected and priced, while a great deal of it will remain free. Some of the content will be free because the marginal cost of protecting it is higher than the marginal benefit. Other content will be free because its production and distribution are subsidized. Other content will be valuable enough to warrant technological protection.

This is the state of television today. Some programs, such as movies on HBO, are protected from piracy and priced. The programs broadcast by most networks are subsidized by advertising, and consumers are not charged directly for receiving them. Some content, such as public access cable TV shows, are not valuable enough to receive either protection or production subsidies.

This section examines how the creation and distribution of digital information that is freely available is paid for now, and how this could change given the unique nature of digital content. Currently, some free information is given away to generate "upgrades" to related products, or given away as publicity for the content producer. Other free information is subsidized indirectly by third parties via advertising. In the future, it's even possible that consumers could be paid directly for receiving advertising. This section also examines how technology could allow content producers to practice effective price discrimination for protected content.

4.1.1 Upgrades and Publicity: Earning Profits from Free Content

Most digital content on computer networks is currently not priced. Once a consumer has joined an online service and paid that service provider, virtually all content available via that service is free. Eventually, some content will be priced when its duplication can be controlled technologically. But there will continue to be a great deal of free, unsubsidized content available on computer networks for several reasons.

One reason is the short useful life of much content. Some content continues to have great value long after its creation. The works of Shakespeare, Mozart, and Renoir are still extremely popular and valuable today, long after their original creation. Much content, however, has a much shorter useful life. For instance, a market survey predicting sales growth for the second half of 1995 is already obsolete and essentially worthless. If content has a very short useful life, the marginal cost of protecting it may exceed the marginal benefit. This is one reason that a great deal of content will continue to be free.

Another reason that much content will continue to be free is that it will be purposely given away to serve as advertising to promote firms' other services (Dyson, 1994). There are two distinct models by which firms can try to earn profits by giving away unsubsidized content: the upgrade model and the publicity model.

4.1.1.1 The Upgrade Model

Last month's *Newsweek* magazine isn't nearly as valuable to most people as this week's issue. This is part of the reason that protecting one piece of content that has a short life cycle is not nearly as valuable as producing on ongoing series of valued content (Jussawalla, 1992).

This long-term view is prevalent in the shrink-wrap personal computer software market today. In the late 1980s, high-priced programs such as Lotus 1-2-3 and dBase III (typically costing about $500) used copy protection schemes to try and prevent illegal duplication. These schemes prevented anyone, including users who had purchased genuine copies of the software, from making copies of it. Personal computer users who owned legitimate copies of this software found the copy protection mechanisms too burdensome, and software companies stopped using copy protection. Virtually no shrink-wrap software uses such schemes today. Instead, the focus of software companies is to produce a continually-evolving line of products, and try to earn a large portion of their revenue from selling product upgrades to current customers. Some companies give away some of their products freely in hopes of creating markets for versions of their products that have more features, or for related products. This is the strategy that Netscape employs in giving away its Web browser software. Doing so has earned Netscape a huge market share of the Web browser market, attracted numerous development partners, undoubtedly aided sales of its Web server software, and led to one of the most publicized initial public stock offerings in recent years.

Currently, most software upgrades take the form of major product releases — e.g., upgrading from Microsoft Word version 6.0 to version 7.0. Producing a major new version requires thousands of hours of engineering, testing, and marketing effort, and typically takes between one and two years. This defines the life cycle of personal computer software. A recent trend among major software packages is the ability to support small, incremental feature enhancements via separate programs that work in conjunction with the main program. Such programs are variously called *add-ins*, *plug-ins*, or *additions*. Software that has such support includes Netscape Navigator, Microsoft Word and Excel, and Adobe Photoshop, PageMaker, and Acrobat. Such plug-ins typically solve a well-defined, small problem, or add one feature to the main program. Thus, they can be developed with much less effort, and sold only to the customers for whom that feature is valuable. (Because of the specificity of the solution, plug-ins probably result in greater price discrimination by firms.) The life cycle of such plug-ins is often shorter than the life cycle of the main program, because the functionality of popular ones are often built into the next major release of the main program.

Content producers could follow a similar model, giving away baseline versions of their content, and selling upgrades to newer or more complete versions. They could also sell content additions, conceptually similar to software plug-ins, that provide consumers with more detailed information about a particular aspect of the original content.

Plug-ins typically allow so-called third-party developers (companies other than the program's producer) to write plug-ins. This makes the program more valuable, because there are many firms attempting to meet users' needs. Content producers could attempt this as well, creating content that consumers buy because it can be augmented by third-party companies to better meet their needs.

4.1.1.2 The Publicity Model

Hundreds of thousands of companies and individuals are putting content onto the Internet, mostly onto the World Wide Web. Some of these web sites contain information that is very costly to assemble, and have very sophisticated user interfaces that require costly programming to achieve. Given that most of these sites do not charge for access and can be used by anyone, how are they funded?

Many web sites are the home pages of companies; for example, Disney (www.disney.com), MCI (www.mci.com), or IBM (www.ibm.com). These companies either use internal resources to create and maintain their site, or hire an advertising agency, multimedia developer, or web site service bureau to do it for them. In any case, they absorb the costs of their web site, typically as a sales, marketing, or customer support expense. Many other web sites are created and maintained by individuals, who typically pay $10-30 per month to an Internet service provider for hosting their page.

Corporate web pages often contain valuable information that the company formerly sold, or possibly even continues to sell through other channels. These pages bring in no direct revenue; they serve only as advertising for the company and its products. For instance, Sun Microsystems' home page contains the complete Software Development Kit (SDK) for their Java™ programming language. Anyone with a Web browser can download this SDK and begin writing Java programs. In the past, Sun and other companies have earned a great deal of money by selling SDKs. Sun apparently believes that, in the short run, it is more important to create support for Java and make it a long-term standard than earn revenue from it.

4.1.2 Advertising Subsidies for Digital Information

In addition to Web pages subsidized directly by companies and content producers, many Web pages are subsidized by third parties via advertising. These are usually for-profit Web pages owned by companies that were started specifically to earn money by providing free content. Examples include the Yahoo search engine and c|net, an Internet publisher. These Web pages attempt to supply compelling, timely content or valuable services that attract large numbers of computer users, which in turn attracts advertisers. Many people believe that the most engaging content on networks such as the Web will be advertising-subsidized.

What attracts advertisers to place ads on computer networks is the ability to target their ads very specifically to the audience they believe is most interested in their message. Advertisers already target their ads to their audience. For instance, *Car & Driver* magazine is full of ads for new cars and car accessories, not for gardening equipment. Similarly, Geritol is not advertised during Saturday morning cartoons. Computer networks allow for even more highly focused advertising than traditional media. A common technique for focusing online ads is for an advertiser to pay a Web search engine such as Yahoo a fee to show its ad every time a particular word is typed. For instance, suppose an Internet user is going to buy a new car, and searches the Web for information about this year's models. He or she might use Yahoo's search engine to help locate this information. Yahoo prompts the user to type the topic to be researched. When the user types "automobile" or "trucks," an ad for a CNN show about cars appears, because CNN has purchased the right to associate their ad with these topics. Similarly, a search for "computers" brings forth an IBM ad. Searching for "music" brings up and ad from Yahoo itself that says "Promote your music website on a banner like this — Click here for details!". (The search topic "economics" does not yet have an associated ad.) This technique is very new, and is not being heavily used yet, but it does allow targeting of ads only to people who are known to be interested in a particular topic at a particular time.

Advertisers appear willing to pay a premium for such focused delivery. One advertising agency found that the cost of reaching 1,000 people via electronic magazines' Web pages was 40 times higher than via print ads in those same magazines, and yet some Web sites are able to sell space on their pages for up to $30,000 per month (Paulson, 1995).

Another difference between online and traditional advertising is the possibility that advertisers could pay users directly for seeing an ad. This is not yet being done, but should be possible if Digicash or other electronic payment systems become feasible. Advertisers would also be able to charge consumers who sought out their ads. These two concepts are explored in detail in the following sections.

4.1.2.1 Supply and Demand for Advertising

Comanor and Wilson developed a supply and demand model for advertising messages (Comanor & Wilson, 1974). Their model was published in 1974, and reflects the realities of advertising technologies available then. A reexamination of this model in light of current technologies requires a detailed examination of it.

In Comanor and Wilson's model, both consumers seeking to buy products and firms seeking to sell products demand advertising. Consumers demand it to obtain information, and firms demand it to transmit their messages to consumers. The firm pays information media to carry its advertising. Because consumers are not charged for receiving ads, the marginal revenue of advertising is the extra profit earned when more units are sold, or are sold at a higher price, due to the advertising. Equilibrium is achieved when this marginal revenue equals the marginal cost of producing and broadcasting the ad. The market for advertising messages is assumed to be competitive, so the total demand is the sum of the individual firms' demand curves. The demand and supply curves take the following form:

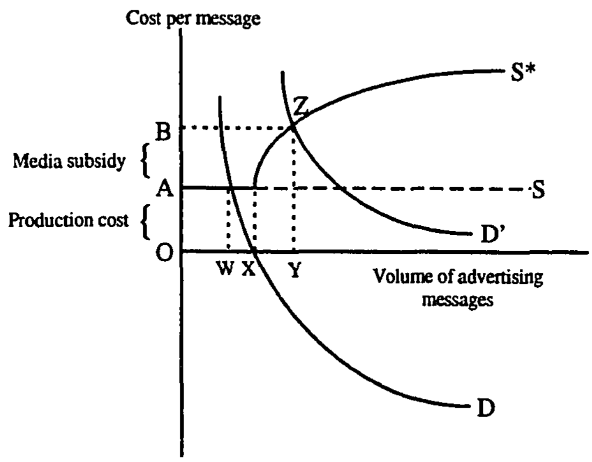


Figure 1. Supply and Demand for Advertising Messages

The demand curve *D* represents aggregate consumer demand for advertising messages. Beyond point *X*, the price is negative, indicating that consumers must be paid to receive messages beyond *X* amount. The demand curve D' represents aggregate firm demand for advertising messages. The supply curve is simply the marginal cost curve where the costs come in two forms. Between *O* and *X*, this curve consists of the cost of producing and distributing these message; these costs are assumed to be constant, so supply curve *S* is flat. Beyond point *X* though, consumers' demand for messages is satiated, so they must be compensated for receiving them. This compensation takes the form of information and entertainment media subsidies, and is reflected in the curve S^*, which is the sum of *S* and the vertical distance between *D* and the horizontal axis beyond *X* quantity of messages. S^* is not drawn between *O* and *X*, because of the excessive transaction costs of obtaining payments from consumers who receive the messages. *OY* represents the volume of messages supplied, and *OB* the cost per message, which is made up of the production costs and the subsidy.

Advertising is usually supplied at a zero price to consumers, or, as in the Comanor and Wilson model, a negative price. Yet advertising consumes resources to produce and distribute. Thus, it is often argued that too much advertising is supplied (Telser, 1966). In Figure 1, for instance, *OW* messages represent the efficient level of supply; this is less than the *OY* that are supplied. The validity of this argument rests on which demand curve, *D* or D', is used. This in turn depends on whether advertising is viewed as being supplied jointly with the product it advertises, or jointly with the content supplied by the media. Comanor and Wilson's model is based on advertising being supplied jointly with media content, not with its product. They base this in part on the fact that advertising is consumed for products that the buyer does not purchase. If demand curve D', the firms' aggregate demand curve, is used, then the optimal level of advertising is supplied.

4.1.2.2 Augmenting the Model

The first change to this model is to allow consumers to be charged for receiving the advertising they seek. This is technically possible today on networks such as America On Line (AOL) and CompuServe. It will probably become technically possible on the Internet in the next few years. On all of these networks, the computer that supplies the information knows what information is being supplied, for how long, and to whom. On private networks such as AOL, this same computer system already tracks time spent online and manages billing for each user. These computer systems could charge users each time they sought an ad and read it. If efficient digital cash systems become available on the Internet, it will be possible to charge users of this network for information as well.

What would the shape of the supply and demand curves be if consumers were charged for advertising information they sought, and the transaction costs of doing so were small? Figure 2 shows the updated supply and demand curves.

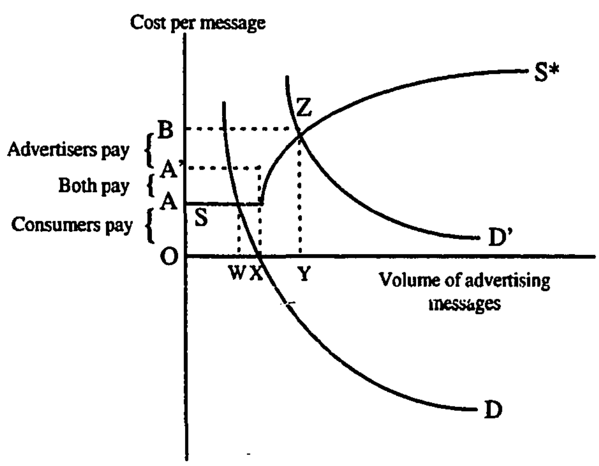


Figure 2. Supply and Demand for Advertising Messages, Consumers are Charged

The firms' aggregate marginal cost curves, *S* and S^*, are unchanged. The marginal revenue earned by the firms has changed, because consumers are charged when the demand curve *D* lies above the horizontal axis. From *O* to *A*, consumers' demand is sufficient to pay the cost of messages. From A to A', aggregate consumer demand is still positive, but not large enough to cover all costs of producing and distributing advertising messages. Consumers are willing to pay a positive price for an ad, but this price is less than the marginal cost of the ad. Thus, firms partially subsidize advertising in this region.

Above A', aggregate consumer demand is negative, so as before, advertisers must pay not only the cost of producing and distributing their messages, but must also pay consumers an inducement to receive them; this inducement is the media subsidy. Beyond *OX*, the firms' aggregate demand for advertising messages is unchanged, so equilibrium obtains again at *Z*.

The second change to the model is to allow advertisers to pay consumers directly for receiving ads beyond the quantity demanded, rather than paying them indirectly via media subsidies. This is technically possible via the same mechanisms that could charge consumers for ads they sought; only the direction of the payment is different. In Comanor and Wilson's model, advertising is supplied jointly with media content. If consumers are paid directly for receiving ads, then advertising is somewhat decoupled from media content. Firms might still supply advertising beyond the point where consumer demand becomes negative; they do so up until the point the marginal revenue of an ad, measured by the extra profits it creates, equals the marginal cost. The cost a TV ad is between approximately $12.50 and $31.50 per thousand messages provided, based on Comanor and Wilson's data, adjusted for inflation. The marginal cost of a single advertising message is then between 1.25 and 3.15 cents. As Comanor and Wilson point out, consumers would probably have to be paid much more than this per ad to induce them to receive the volume of advertising they currently receive. A higher payment demanded reflects the fact that consumers' negative demand for ads lessens even further when they are paid directly for receiving ads. Consumers currently have little choice about whether to receive these ads, because the ads are inserted in the midst of the programming the consumers do demand. Thus, advertisers are able to pay relatively low prices for distributing their ads.

Comanor and Wilson's model does not differentiate between types of advertising. Direct payment to consumers appears even less practical when this is considered. It is probable that much of the positive demand consumers have for advertising is for informative ads, rather than persuasive ads. Consumers thus value persuasive ads less than informative ads, and would demand higher payment for receiving excessive persuasive ads. For instance, ads for Coca-Cola are almost entirely persuasive, containing virtually no information. Consumers have see hundreds or even thousands of Coke ads every year. Most consumers probably put a very small value, if any, on seeing an additional Coca-Cola ad. In contrast, an ad for an upcoming furniture sale has informational value, especially to consumers in the market for new furniture. Coke will probably have to pay consumers more to view their ads than the furniture store. Thus, consumers' aggregate demand curve for persuasive ads is shifted down even farther than their demand curve for informative ads. The marginal cost of ads, especially persuasive ads, will be higher if consumers are paid directly to receive excess ads, rather than being paid indirectly via a media subsidy.

This higher marginal cost would be somewhat offset, though, by the ability to focus advertising toward interested consumers. This reduces the need to broadcast ads widely in hopes that interested consumers happen to see them. Thus, both the supply curve and the advertisers' aggregate demand curve shift.

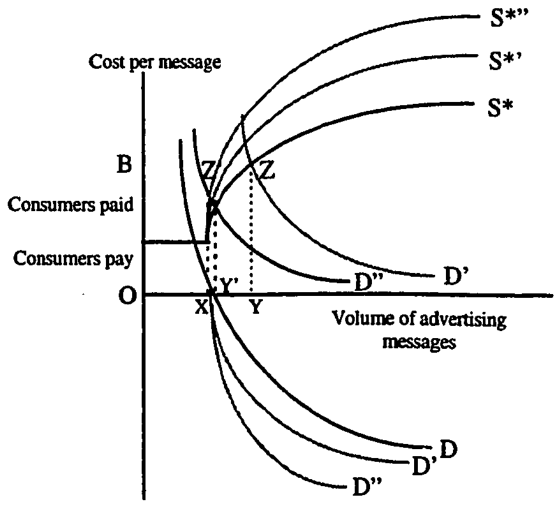


Figure 3. Supply and Demand for Advertising Messages, Consumers are Charged or Paid

In Figure 3,the supply curve beyond *OX* shifts upward, from S^* to $S^{*'}$ to represent the increased marginal cost of paying consumers directly to receive informational ads. It is shifted up further, from $S^{*'}$ to $S^{*''}$ to reflect the higher marginal cost of paying consumers directly to receive persuasive ads. These supply curve shifts are induced by the downward shifts in consumers' demand curves that reflect their demand for higher compensation than they receive via the indirect media subsidy.

The advertisers' demand curve shifts inward, from D' to D'', reflecting the fact that they demand less advertising because they are able to focus ads toward interested consumers. Instead of OY messages, fewer messages, OY', are supplied. Whether the cost per message increases or decreases, and whether a direct payment system is practical, depends on the shift and slope of the various supply and demand curves.

4.1.3 Price Discrimination

Another issue that affects the price of digital content is price discrimination, which occurs when a seller charges a different amount to different buyers for the same good. Because each person values a particular good differently, people are willing to pay different amounts for that good. Much of the time, however, it is not feasible for a seller to determine each person's willingness to pay, so everyone is charged the same price. For instance, suppose you are eager to buy today's newspaper because it contains an article about your bowling team's recent championship. The newspaper costs only $0.50, but you would be willing to pay $3 for it today. The newspaper vendor can't take the time to negotiate with each buyer, so you get to buy the paper for only $0.50. Because you're willing to pay $3 for it, your consumer's surplus is $2.50. If the vendor had the time to negotiate with you, she might capture some of this consumer's surplus by getting you to pay $1.50 for the paper.

There are many instances where price discrimination is effectively practiced. For instance, when you buy a car, you usually negotiate with the salesperson over the price. Another consumer who is a more effective negotiator may have bought a virtually identical car from that salesperson the day before for $1,000 less than you paid.

Price discrimination is possible if the firm has some monopoly power, the buyer is unable to resell the good, and buyers in different markets have different elasticities of demand for the good. These conditions can exist for information goods such as books. Indeed, publishers have practiced price discrimination since at least the nineteenth century by selling only an expensive hard cover version of a book for a period of time before publishing a less expensive paperback version (Plant, 1934). Price discrimination can be practiced even more effectively for digital content on computer networks.

The first condition, monopoly power, exists to the extent that a firm offers a unique bundle of content. Because of the ease of publishing content on a network such as the Internet, it is probably more difficult to create a unique bundle of digital content than physical content. But factors such as respected brand names, access to the most recent data, and adequate resources to package and promote goods will continue to create information monopolies in spite of the ease of entry for distribution.

The second condition is the inability of consumers to resell the good. Technology such as cryptolopes promise to enforce this condition in the near future. Legal sanctions also inhibit widespread reselling of content. For instance, a user could retrieve information from an expensive online database and resell it, but widespread resale will attract the attention of the authorities. Police knowbots might be able to detect illegal duplication automatically. Because of this, black market activity must stay deep underground. This causes high transaction costs for buyers and sellers on the black market and limits its size (Rose, 1994).

The third necessary condition, buyers in different markets with different elasticities of demand, is enabled by the malleable nature of digital content, which can be easily manipulated by software. This allows the firm to create different markets by creating different versions of essentially the same content. These conditions will allow content providers to offer different forms of the same basic information, and charge different prices for these forms.

There are several ways in which this could be accomplished. For instance, the information could be provided in one form that allows it to be read and printed, but not extracted for reuse by the buyer. It could also be supplied in another, higher-priced form that allows extraction and reuse. Another method will be made possible by cryptolopes. One version of some content could be sold in a cryptolope that did not allow copies of the content to be made. Another, higher-priced version would allow copies. This is analogous to academic journals that charge higher subscription rates to libraries than to individuals in an effort to capture some of the consumer benefit of photocopying. This method varies the quality of the good in order to ensure that buyers with a low willingness to pay do not receive the same good as buyers with a higher willingness to pay (Varian, 1995).

The two examples described above involve preprocessing of the information to create several different versions that are offered. More sophisticated price discrimination is possible with purchase-time processing of the information, because this allows the monopolist to produce a product that more exactly meets the buyer's needs, and therefore extracts more of their willingness to pay. For instance, a piece of content could have a base price. For that base price, the buyer receives an un-augmented version of the content. To the extent that the buyer's willingness-to-pay exceeds this base price, the selling firm adds hypertext links to related information, explanatory figures and graphs, and other additions that enhance the value of the content. This allows the firm to capture much of the consumer surplus.

Another method for price discrimination involves serving markets with heterogeneous tastes. In these markets, "rich" consumers buy a good, while "poor" consumers rent the good. Without price discrimination, the firm must decide whether to price the good for rich consumers and forgo sales to poor consumers, or price the good for poor consumers and allow rich consumers to buy for a price much lower than their reservation price. Price discrimination enables a firm to sell goods closer to the rich consumers' reservation prices, while also serving the poor consumers. The resulting market expansion increases the firm's profits. Again, hard cover books are an example of this type of price discrimination. Rich consumers buy hard cover books, while poor consumers "rent" them from public libraries (the price being the time they spend obtaining the book), or buy the paperback version (the price being the months they go without the book before the paperback version is published) (Varian, 1996). Cryptolope technologies will enable firms to sell copies of content to buyers who pay a high price, and rent copies to other buyers at a lower price. The rental copies could self-destruct at the end of the rental period, much like the audio tape did every week in the TV show *Mission Impossible*.

Another possible method for firms to practice price discrimination lies in their ability to negotiate the price of a good. If a firm can uncover the buyer's reservation price, it can charge the user that price. If knowbots are negotiating on behalf of both buyers and sellers, then the knowbot with the most negotiating skills will "win" the negotiation. For instance, suppose the firm's knowbot is a clever negotiator, and the consumer's knowbot isn't. Specifically, the firm's knowbot is programmed to attempt to receive the highest price the buyer's knowbot is willing to pay, while the buyer's knowbot is programmed simply to accept any offering price less than or equal to the buyer's reservation price. The firm's knowbot offers the content to the buyer's knowbot for a very high price, which the buyer's knowbot declines. The firm's knowbot keeps reducing the offering price slightly until the buyer's knowbot accepts. The firm has just captured the buyer's consumer surplus. If this scenario comes to pass, a technology race will occur between buyers' and sellers' knowbots. Each side will continue to add negotiating tactics to its knowbots in an attempt to reveal or conceal the sellers' and buyers' reservation prices. Companies will be founded to provide this technology, and some fortunes will be made. When all knowbots have been programmed with all known negotiating tactics, equilibrium will be regained. At this point, willingness to pay will not be revealed during price negotiation, just as it is not usually revealed now between two capable human negotiators.

4.2 Transaction Costs

In addition to affecting prices, the unique nature of digital content and computer networks will affect transaction costs. Transaction costs are the indirect costs of a transaction. For instance, when you buy a house, the realtor receives a commission, the title company is paid for title insurance, and various fees are assessed for title recordation, document preparation, and so on. These costs, which are very substantial in this case, are the transaction costs of buying a house.

In practice, there exists a continuum of transaction costs proportional to the associated risk. For instance, buying a house has very high transaction costs because large sums of money are involved. Power of attorney and wills also have rather high transaction costs. Buying a car has lower, but still significant, transaction costs. At the other end of the continuum is a small cash retail purchase, which has almost no transaction costs (Perritt, 1994).

As with digital content pricing, there are again two visions of the future. One foresees electronic commerce lowering transaction costs, and one sees electronic commerce either leaving transaction costs unchanged, or even raising them.

4.2.1 Transaction Costs for Digital Content

A technological system that protects intellectual property rights for digital content creates new transaction costs. Will these costs be proportionate to the risks involved? Perritt believes that encryption systems will impose disproportionate transaction costs for many transactions. Strong, on the other hand, believes that enlightened businesses will create appropriate levels of transaction costs, and will prosper. Businesses that are overly worried about receiving payment for every last use of their content will impose excessive transaction costs, and will lose customers (Strong, 1994).

Transaction costs are created not just between the seller and buyer directly, but also by intermediaries, such as wholesalers, distributors, and retailers. It is widely speculated that electronic distribution of content, and the corresponding electronic commerce in this content, will reduce or even eliminate the need for most intermediaries, because buyers and sellers will be able to connect directly or through their knowbots. This could simultaneously allow both higher profits to producers and lower prices for consumers. Sarkar *et al* believe, however, that the role and number of intermediaries will be increased, rather than reduced.

One instance where this will occur is in situations where the technology of the network allows intermediaries to increase the efficiency of exchanges by combining transactions to create economies of scale. Intermediaries will also continue to aid customers in ways they currently do in the physical world, such as searching for appropriate products, evaluating their quality, assisting customers with needs assessment and product matching, reducing risk via return guarantees, packaging bundles of goods, and delivering goods. Intermediaries will also aid producers in the same ways they do in the physical world, including providing customer information and reducing the risk of fraud and theft. Sarker identifies classes of cyber-intermediaries that exist now, or will probably exist in the near future. The following table takes each of Sarkar's cyber-intermediaries (Sarkar, Butler & Steinfield, 1995) and lists current examples and the value each adds to the information exchange process:

Type of Intermediary	Example	Value Added
Directory	Yahoo	Organizes Web pages into categories
Search services	WebCrawler, Lycos	Allows users to search entire Internet
Malls	VirMall	Brings together many retailers
Publishers	Wired Magazine	Publishes magazine excerpts
Virtual resellers	CD Now	Allows ordering of any CD
Web site evaluators	Magellan	Provides rating services
Barter networks	BarterNet	Brings barterers together
Auditors	Nielsen Interactive Services	Counts site visits, and provides user demographics
Forums, User groups	The Motley Fool	Provides investment advice and a discussion forum
Financial firms	Digicash, Checkfree	Electronic payment systems
Intelligent agents[1]	IBM InfoSage	User-tailored news clipping services

Table 2: Cyber-Intermediaries

Like Sarkar, Dyson also argues that computer networks will give rise to more intermediaries, rather than fewer. Computer networks will contain an overwhelming amount of content, and intermediaries will be necessary to sift through it and separate the wheat from the chaff (Dyson, 1994).

This author's experience writing this thesis would tend to concur with the view that intermediaries will still have value on networks. A large number of research papers, conference proceedings, and articles referenced in this paper were found on the Internet. Many other articles came from traditional print journals. In this author's opinion, the quality of the papers available freely via the Internet varied much more than materials from refereed journals or

[1] An intelligent agent is a software program that is able to search on its own to satisfy a human's demands. For instance, an intelligent agent might roam a network looking for information about a person's favorite topic, such as Shakespearean literature. The agent is dispatched, and eventually returns to report the results of its search.

published books. There was much more chaff than wheat among the Internet articles, while the reverse was true of refereed articles and published books.

On the other hand, Wigand believes that electronic distribution and commerce will reduce the number of intermediaries. As more producers make their products available via networks, and more consumers connect to these networks, markets will move toward being perfectly competitive. The pressure to shore up sagging profits will force producers to integrate functions vertically, eliminating intermediaries (Wigand & Benjamin, 1995).

As electronic distribution and commerce become more widespread, there will be opportunities for empirical research to investigate the effects of transaction costs.

4.3 New Types of Value: Meta-Information

The unique nature of digital content on computer networks will affect both prices and transaction costs. These affect the price and value of existing goods. The unique nature of digital content will also enable creation of new types of value. One example of this is meta-information.

As described in Chapter 2, meta-information is a different level of information than the information sought by consumers; it's information about information. Meta-information has value. For instance, marketers are interested in lists of people who meet certain demographic criteria and who are also interested in certain avocations. An example might be college students who are interested in skiing. By cross referencing requests made via the network for information on skiing with e-mail addresses originating from universities, such a list can be developed. Another example of the value of meta-information is the fact that the Direct Marketing Association reported that it would pay phone companies $3 per name and address for a list of telephone customers who called certain toll-free 800 numbers (Phillips, 1994).

If electronic commerce becomes widespread, computers will be used to purchase goods, and other computers will fulfill and track these purchases. Marketers will place a high value on meta-information derived from electronic commerce because it will be based not just on expressed interests, but on actual purchases.

Meta-information can have value directly to the people who collect it. For example, suppose a software company has a World Wide Web home page that Internet users visit to learn about the company and its products. With current technology, the software company can often detect which operating system (e.g., Windows 95, Mac OS, Windows 3.1) is used by the computer accessing their home page. When collected and analyzed, this data can be used to create meta-information about the relative operating systems' market share among their potential customers. The company might learn, for example, that many more people interested in their software use a Macintosh than a Windows-based computer. This information could help the company make a decision about which operating system to support first with its software.

Often, the value of meta-information is increased by combining it with other information. For example, one popular Web site analyzed which Internet service provider was used by people who visited their site. They calculated that in late 1995, approximately 75% of Internet users were connecting to it via America On-Line (AOL) (Steiny, 1996). AOL provides a very easy mechanism for connecting to the Internet, and is much more popular than competitors such as CompuServe, The Microsoft Network, or smaller Internet service providers such as Netcom. Thus, this meta-information is not too surprising. It becomes more valuable when combined with the recent announcement by AOL that it will provide Microsoft's Internet Explorer Web browser for its users, rather than Netscape's Web browser. The meta-information amplifies the importance of the announcement, because with a 75% market share of Internet users, AOL has the ability to cause dramatic shifts in the market share for Web browsers.

4.4 Chapter Conclusion

This chapter examined three issues of value and pricing of digital content on networks: the price of information goods, transaction costs associated with information goods, and the ability to create new types of value.

The price of information goods is already different when they are in digital form, because most digital content is free, even if its equivalent non-digital version is priced. Even when technology enables pricing of these goods, much of will remain free because of its short useful life, its value as publicity or an upgrade-generator for the content creator, or its subsidization by advertisers.

The upgrade model depends on firms' ability to offer a more valuable version of the good to consumers of the current version. Sometimes, the current version is priced, and sometimes it is given away freely. This model is prevalent in the shrink-wrap personal computer software market. The ability to quickly offer incremental upgrades, rather than occasionally offering a single comprehensive upgrade, is a growing trend in the software market. Digital content producers could apply this model by selling augmentations to baseline versions of their content. Enabling third-party upgrades can also enhance the baseline product's value.

The publicity model generates revenue less directly than the upgrade model. In this model, companies simply give away content in hopes that the resulting publicity will help them garner revenue in some unspecified way later.

Advertisers are attracted to computer networks because of the ability to more closely focus their ads toward interested consumers. The technology of computer networks could change the economics of advertising. For instance, consumers could be charged for advertising information they sought. Conversely, they could be paid directly to receive excess advertising, rather than being paid indirectly via a media subsidy.

Consumers currently receive ads for free, even if they sought an ad for information purposes. Advertisers are unable to practice price discrimination because the transaction costs of tracking which consumer has seen which ad and then charging them are prohibitive. Computer networks already track what information is seen by each user; electronic payment systems could enable advertisers to charge consumers for ads.

Advertisers' aggregate demand for ads exceeds consumers' aggregate demand for those ads. Beyond the point that consumer demand for ads is satisfied, advertisers currently induce consumers to receive these excess ads by subsidizing information media. As with charging consumers for ads, the transaction costs of paying consumers directly for receiving ads is too high in traditional markets. Just as computer networks and electronic payment systems could enable advertisers to charge consumers for ads they sought, these systems could enable advertisers to pay consumers directly for receiving excess ads. This system might not be more efficient than the indirect subsidy, however, because consumers might demand higher payments for ads than they currently receive via the subsidy. This is especially true of persuasive ads. This higher marginal cost of ads could be at least somewhat offset by advertisers' ability to target ads to interested consumers.

The price of digital content will also be affected by price discrimination, which the market for digital content provides appropriate conditions and ample opportunities to practice. Different quality versions of a good can be created.

Indeed, because of the ease with which digital information can be manipulated, many different quality versions of a single good can easily be created. If knowbots are allowed to negotiate contracts on behalf of buyers and sellers, a technology race to embed sophisticated negotiating abilities in these knowbots is likely.

Transaction costs occur directly between buyers and sellers, and also when intermediaries are involved in transactions. Some researchers believe that the transaction costs associated with digital content on networks will be lower than in traditional information markets; some researchers believe they will be higher. Much depends on the role of intermediaries, whom some researchers believe will become less important as buyers and sellers are able to connect directly via the network. Others believe that intermediaries will continue to play important roles, such as evaluating product quality, packaging bundles of goods, and offering return guarantees. This question could benefit from empirical research.

Meta-information, which is information about how people seek and use information, has value. It is especially relevant in digital content markets because computer networks enable the collection and creation of meta-information on a much more widespread basis than currently available in traditional markets. Meta-information's value can be magnified by combining it with other information.

5. Conclusion

This thesis examined economic issues of intellectual property rights and pricing for digital intellectual property on computer networks. Several factors make these issues worthy of examination. The most important factor is the unique nature of digital intellectual property, or digital content, which can be perfectly duplicated for almost no cost. In economic terms, the marginal cost of production for digital content is near zero, and a copy is a perfect substitute for the original. This is quite different from non-digital intellectual property, such as books. These physical goods require relatively costly reproduction in order for another copy, either legal or illegal, to be made. Copying digital content is not only less expensive, it's easier. Unlike physical goods, digital content is easy to duplicate using the same machinery used to access it — a computer. Furthermore, illegal copies are usually of lower quality than the original.

Intellectual property rights protection such as copyright protects not an idea itself, but the particular expression of an idea. This works well for physical goods, since the expression of an idea cannot be used without its physical embodiment. Enforcement of copyright for these goods focuses on preventing creation and distribution of unauthorized copies of the physical container for the expression of an idea. For instance, news reports occasionally tell of warehouses full of counterfeit music or computer CDs being confiscated. The second factor affecting digital content usage is the lack of a physical embodiment. Police will never raid a warehouse full of illegal copies of a piece of digital content, because copies can be created at will and are stored on computers around the globe.

Digital content can be duplicated perfectly, easily, and for very little cost. It has no physical embodiment whose production and distribution can be controlled. Thus, digital content on networks is essentially an open-access resource, available equally to all. This combination of factors means that once an idea is expressed digitally and placed on a computer network, it is likely to be copied widely. Content creators currently have few methods available for receiving direct payment for their work. They are unable to capture the benefit stream created by their work, and thus, the private benefit they receive is less than the social benefit they create. This leads to underproduction of the content from society's point of view. Underproduction due to insufficient incentives is a common externality of open-access resources, and is a major problem of digital content on networks.

The third factor that makes these issues worthy of examination is the rapid growth in the number and interconnectedness of computer networks. Many companies are rushing to create a presence on the Internet's World Wide Web, and consumers are rushing to get onto the Web. Thus, problems of intellectual property and pricing issues for digital content are increasing in scope daily.

The final factor making these issues worthy of examination is the ongoing development of technological systems to protect digital content on networks.

These systems affect both property rights protection and pricing, and will have a major impact both on content creators' incentive to distribute content and on people's ability to utilize that content. This raises important social welfare questions.

These issues were examined by investigating three key questions. First, because digital intellectual property on a computer network is an open-access resource, which externalities typical of open-access resources are relevant, and which are not, and how can these externalities be reduced? Second, how does increased protection of digital intellectual property from unauthorized duplication and use affect efficient use of that content? Third, how does digital content fit into traditional economic models for information pricing, taking into account new types of value that are created by the digital nature of this content?

Open-access resources are available to anyone; no one is prevented from using the resource. A common example of an open-access natural resource is a fishery. With no fences, anyone is free to enter the fishery and catch as many fish as they can. For this reason, fisheries are often over-fished to the point that fish stocks are exhausted. In addition to overuse beyond the socially optimal point, open-access resources often suffer from several other types of externalities, including intertemporal externalities, underproduction, and the inability to transfer resources to higher-value uses.

Two of these open-access externalities do not typically occur with digital content because its use is non-rivalrous. An additional copy of the good can easily be made, and that copy is a perfect duplicate of the original. Thus, overuse does not occur. It also means that one person's possession of a piece of digital content does not prevent another person from also using it simultaneously for a higher-valued use. Intertemporal externalities are also rare, in part because digital content's non-rivalrous nature makes it endlessly renewable. The short useful life of much digital content also reduces the occurrence of intertemporal externalities. The externality of underproduction does occur with digital content.

Many companies are hoping to increase content producers' incentive to create and distribute digital content by developing technologies that protect content from unauthorized use and duplication. These systems use cryptography to create the equivalent of a physical container for the content. Access to the cryptographic envelope, or cryptolope, can be controlled, and thus, so can access to the content itself. These systems create an artificial embodiment of digital content; the use of this embodiment can be controlled. Firms are also developing electronic payment systems that will enable content creators to receive payment for use of their protected works.

Cryptolope systems could provide far more comprehensive intellectual property rights protection than is available for physical goods. Once a person has a book in their possession, they can read it, share it with others, or even resell it. Portions of the book that are particularly interesting to the reader can be photocopied. Cryptolope systems have the potential to disallow all of these activities for digital content unless payment is first made to the rights holder.

While this might create optimal incentives from a content creator's point of view, the restrictions could increase under-utilization of content, which would negatively impact social welfare. An extreme result of such restrictions could be the exclusion of digital content from lending libraries.

These restriction are particularly worrisome in regards to fair use of copyrighted material. Fair use allows people to use content without the rights holder's permission for activities such as research, teaching, and criticism. It has been called the engine that drives scientific and artistic progress in the U.S. If cryptolopes do not distinguish fair use from unauthorized use, they will probably not allow fair use at all. This would force researchers and teachers to pay for using content for purposes for which it is freely available today. The federal government's influential White Paper on intellectual property rights for digital content seems to support these technological restrictions on fair use. An important area for further research is the development of an empirical model for estimating the social benefit of fair use and the impact on society of restrictions on fair use.

Suppose, on the other hand, that property rights protection of digital content remains where it currently stands. At this opposite end of the protection continuum, there is almost no protection for digital content. Because cryptolopes are not yet available, digital content on networks can be easily copied by network users. What are the long-term impacts on production incentives of a system that is equivalent to having no copyright protection?

Intuitively, one might think that practically nothing of value would be published without copyright protection. Historically, this is not so. In situations where authors have been unable to secure copyright protection, they are still able to receive payment for their work, and publishers are still able to earn profits. Indeed, works can be divided into three categories: works that earn a positive return even without copyright protection; works that do not earn a positive return even with copyright protection; and works that earn a positive return only with copyright protection. The existence of copyright protection enables works in the third category to be published, which has a positive effect on social welfare. But copyright protection also has two negative effects. First, works that would be published anyway are priced higher due to the creation by copyright of a monopoly in the good. Second, some of the sub-marginal works are subsidized by these extra profits and published. Because these works do not generate enough value to society to cover their costs, their publication is socially sub-optimal. Copyright creates other social costs as well. Efforts are put into creating substitute works that would not be necessary if the original work didn't have monopoly pricing. For these reasons, it is very difficult to determine whether copyright protection of intellectual property maximizes social welfare.

Technological development such as cryptolopes could enable contracts to supplant copyright as the preferred method for protecting digital intellectual property. The transaction costs of contracting are too high for physical goods such as books; a publisher cannot reasonably enter into a contract with every book buyer. Technologies such as cryptolopes and header contracts could enable intelligent agents, or knowbots, to negotiate a contract between each buyer and seller.

A contract-based system has distinct advantages for sellers. First, a seller can practice price discrimination in several ways. Its knowbot can attempt to use negotiating techniques to extract the buyer's maximum willingness to pay for the good. The ease with which digital content can be manipulated allows the seller to tailor the content to exactly meet the buyer's needs, thus creating a monopoly good. Cryptolopes can prevent buyers from reselling the content, in which case there will be only one market for obtaining the content. Cryptolopes will also allow content producers to sell a copy of a good to one buyer for a high price, and "rent" a copy to another buyer for a lower price. The rental copy self-destructs at the end of the rental period.

A contract-based system can also negatively impact fair use by disallowing uses that are considered fair under copyright law. The White Paper supports these restrictions on fair use. Contract-based systems will also enable sellers to collect more meta-information about consumers' information needs. This meta-information can be used by the sellers or sold to other firms.

Thus, it appears that the development of technological intellectual property protection mechanisms have clear benefits for content producers. The main benefit for content users is increased production of content. Two models were used to examine the question of how underproduction and under-utilization are affected as intellectual property rights protection increases. If the problem is examined statically, the incentive aspect of underproduction is ignored. This leads to the conclusion that property rights protection should be reduced so that people can freely use content, eliminating the social welfare loss due to under-utilization.

Under-utilization includes the loss of welfare due to people forgoing consumption of the good. A more complete dynamic model also takes into account resources expended in obtaining a counterfeit copy of the good beyond the resources required to create an additional, legitimate copy of the good. This occurs because the content creator acts as a monopolist, and charges a price higher than the marginal cost of the good. Any resources expended beyond the marginal cost of production to obtain the good are considered a misallocation of resources from a societal viewpoint. Because an additional unit of digital content can be created for very little cost, but a monopolistic content producer charges a relatively high price for that unit, this effect is significant for these goods. When both of these losses are taken into account, increased intellectual property rights protection does not necessarily decrease social welfare. The decrease in social welfare due to lower consumption can be offset by increased production efficiency as people switch from counterfeit copies to originals.

Underproduction stems from the lack of incentive that content producers have when they cannot capture the entire benefit stream created by their work. Intuitively, the social welfare loss due to underproduction should decrease as intellectual property rights protection increases because the content producers will be able to capture more of the benefits stream. This may not be true for digital content, however, because the cost function for obtaining a reproduction is a decreasing function. As more copies of the content proliferate across the network, people's search costs diminish. Thus, more people will consume copies of the good rather than the original. If the marginal cost of an original remains lower than the marginal cost of a copy, then as consumption shifts from originals to copies, social welfare is adversely affected.

The dynamic model was augmented to include the cost to the content producer of technological property rights protection. This cost decreases social welfare, but the resulting incentive to produce greater quality output increases social welfare.

Property rights protection exists along a continuum, from one end with no protection, to the other end with comprehensive, complete protection. Along the continuum, property rights protection increases. Digital content protection on computer networks is currently at the end offering no protection. Technologies under development could put digital content protection at the comprehensively-protected end of the continuum. What will happen to prices for this content as intellectual property rights protection moves along the continuum?

Predictions that technological protection will result in all "valuable" content being priced are probably not accurate. A great deal of content will continue to be freely available. Some content's useful life is so short that it is not worth protecting. Low barriers to distribution of content on computer networks will create conditions similar to a perfectly competitive market. Almost anyone with a computer and a modem can create richly formatted content and broadcast it to the world. This will help keep the price of digital content low, because for any priced content, there will probably exist similar free content.

How will firms earn a return by giving away free content? Some content's production and distribution will be subsidized by advertisers. This is the state of television today. Some programs, such as cable TV movies, are priced, but a great deal of expensively-produced content is completely subsidized by advertisers. Advertisers on computer networks are able to focus their ads toward people who are interested in their products, rather than simply broadcasting their ads to everyone. Networks could allow advertisers to charge consumers for ads they seek, and pay consumers directly for viewing ads they don't want to see. Currently, consumers are paid indirectly for viewing ads via subsidization of information and entertainment media. Charging consumers for ads would not have an impact on the number of ads. Paying consumers directly for receiving excess ads would probably reduce the number of ads broadcast.

In addition to advertising-subsidized free content, other valuable content will be given away by the content creators themselves to generate publicity and upgrades. The malleable nature of digital content will allow firms to augment freely-distributed baseline versions of their content with customer-specific content additions. Compelling content might also be given away simply to attract people about whom meta-information can be collected.

Transaction costs will also be impacted by the proliferation of digital content on computer networks. There are different visions of the impact, however, Some people believe that computer networks will allow buyers and sellers to interact directly, eliminating many intermediaries. Other people believe that the amount and complexity of digital content will enable intermediaries to continue to add value to transactions. Many types of intermediaries already exist on the computer networks. For instance, although many authors publish their own works on the Internet, there are also many publishers who add value by selecting and editing works and collecting them in one location.

An unanswered question is whether technological protection mechanisms such as cryptolopes and header contract will support appropriate levels of transaction costs for various types of content. High-priced content can bear the burden of high transaction costs, but low-priced content cannot. It remains to be seen if these systems are flexible and efficient enough to work well at both ends of this spectrum.

Computer networks will enable the creation of new types of value. Among these is meta-information, which can be generated more easily on networks than in the physical world. While meta-information has value to entities that gather it, its collection and use threatens network users' privacy. The network usage data generated as they navigate the network searching for and using content can be turned into meta-information that leaves a trail describing their information needs and actions. Property rights in network usage data are unclear, but seem to lie with network operators rather than with the people who use the network. The transaction costs for people to bargain with the many meta-information gatherers they might encounter while using the network are very high; this implies that they will not be successful in obtaining the rights to this information via bargaining. Common property systems are also unlikely to resolve this issue, because the two parties interests' are in direct opposition to one another. It appears that government intervention may be necessary to protect the privacy of people who use computer networks.

In conclusion, the proliferation of digital content on computer networks and changes in people's ability to use this content will affect social welfare in several ways. As intellectual property rights protection increases, content creators' incentives for creating the content will increase, which will lead to increased content production. On the other hand, people's ability to utilize digital content will diminish. Prices of some content will rise as protection increases, but many firms will have to figure out how to earn profits while continuing to give away valuable content. Transaction costs will change as computers become more involved in searching for and obtaining content for people. Society's ability to exercise the fair use doctrine of copyright law for research, education, and criticism may diminish as technologically-enforced contracts replace copyright as the predominant intellectual property protection for digital content. Lastly, a hidden cost of increased use of computer networks may be the diminishment of privacy as meta-information is collected about people's network usage.

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