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A Primer on Internet Economics: Economic Aspects of Digital Information Technologies

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A Primer on Internet Economics[1]

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1 Introduction

One of the major economic developments in the world economy of the last decade has been the complementary globalization of production and the rapid development of information and communication technology as exhibited through the emergence of the Internet. The preliminary analysis presented here is guided by the belief that although the Internet has received a great deal of publicity, there still remains areas of vacuum with regard to research on the economics of the Internet and a more wide-spread understanding of the prime issues involved. After a brief history of the evolution of the Internet industry in section 2, a segmentation map of the Internet industry is presented in order to aid one in understanding potential Internet issues that will affect academics, political regulators, industry leaders, and the general public in the future. Equipped with this greater understanding of the way the Internet functions, economic issues and Internet concepts are selectively identified and discussed within the basic structure of interoperability, network externalities and the equitable statistical sharing of Internet resources.

2 A Brief History of the Internet Industry

Originally, the Internet was conceived during the 1960's by military research with the goal of guaranteeing stable communication in the event that parts of the communication system were destroyed (Lammarsch & Steenweg 1995, p. 3). The United States Ministry of Defense developed a decentralized computer network based on "store-and-forward" software. Messages could be broken down into smaller components, with each individual package receiving the electronic address of the recipient. Such information packages could then be processed by the system and routed to the final destination through any of the channels of the network, and software on the receiving computer would reassemble the packages into one message (Maier & Wildberger 1996, p. 4). Shortly after the initial introduction of this "Advanced Research Project Regency Network" or simply "ARPANET", other governmental agencies, universities, colleges and corporate R&D departments were permitted access (Klau 1995, p. 31). Although the protocol allowing this information transmission (TCP/IP) had been developed in 1974, real commercial usage of the Internet is a relatively new phenomenon of the 1990s (for a recent survey on electronic commerce see e.g. Anderson 1997).

[1] The author wishes to thank Ludwig Nastansky for his helpful comments.

Nowadays the Internet's communications properties are increasingly affecting economic transactions in basically all industries. As the Internet has no centralized authority, it is difficult to give accurate statistics regarding user numbers (Hansen 1996, pp. 52ff.). Millions of computers in more than 40 countries, however, are electronically connected to the world's largest digital network (Anderson & Choobineh 1996, p. 22). Estimates place the number of worldwide users at some 60 million and growing (Ghosh 1998, p. 2). Approximately four million users in Germany have access to the Internet, and market observers forecast that by the year 2000 the number will rise to around ten million (Glanz 1997, p. 129). The Internet represents unprecedented opportunities not only for consumers, but also for businesses of all sizes. Commercial connections are currently the fastest growing component of the Internet (Hauenstein 1996, p. 25). Even the smallest company, by connecting to the Internet generates an international presence, allowing data exchange and support services to flow electronically worldwide (Rüdiger 1996).

The user-friendly surface World Wide Web "WWW" was created in 1989 at CERN (Conseil Européen pour la Recherche Nucléaire), a physics laboratory in Switzerland. Acting as a catalyst to network growth, the possibilities to use all facilities of the Internet with just one easy computer application, i.e. a software program called "web browser" (for example, Netscape Navigator or Microsoft Explorer), became a reality. The economic importance of a web browser will be discussed in more detail below. The WWW integrates such economic activities and services as the gathering of information, the transmission of electronic mail, discussion groups, and the downloading of files from remote servers (Nolden 1995, pp. 11ff.).

The main advantage of the WWW is that it enables the user without requiring far-reaching computer knowledge to explore the Internet through connections called hypertext links. Hypertext links are a method of presenting information stored on scattered servers on a global basis, whereby selected parts within the text can be connected to other web sites, providing additional information on the topic (Krol 1995, p. 334). If a page incorporates a hypertext link, the user can simply click on the link and will be taken to the connected page. Every web page on the Internet has its individual address, the so-called Uniform Resource Location (URL). The Hyper Text Transfer Protocol (HTTP) then accommodates the actions necessary for integrating publishing, computing, and broadcasting on the Internet (see e.g. ILC et al. 1996, Nielsen 1995, p. 14). Public use of the WWW was applied to the Internet in 1993 as an interactive system for the dissemination and retrieval of information and multimedia sources such as audio or video sequence files within a document through web pages. Currently, the WWW is the fastest growing Internet resource and it is considered the most attractive service for business usage (Everts 1996, p. 34, Little 1995, p. 35).

3 A Segmentation Map of the Internet Industry

Since the Internet industry is still evolving it is helpful for understanding the economic fundamentals of transactions on the Internet to grasp the scope of the current state of segmentation of products and services within the Internet industry. A basic understanding of the technology is a prerequisite for economic models. Mapping out the industries basic structure will enable companies, as the market matures, to organize their "...potential products and services in context with other companies and in focus within the rest of the industry." (Dayton 1996, p. 1).

The various building blocks of the Internet industry may be classified according to the so-called Open Systems Interconnection (OSI) model developed by the International Standards Organization (ISO) during the past 15 years. Basically, the OSI model permits developers of the network architecture to work on network problems independently and still obtain compatible system solutions. Working through the various successive layers of the network architecture enhanced network functionality is obtained. The OSI model which defines *how the technology of the Internet underlies the segmentation of its products and services* is briefly illustrated in table 1.

Table 1: Understanding the OSI Model

Layer	Name	Description	Example
7	Application	The communications applications themselves	email, file transfer, client/server applications. Applications such as Netscape & Eudora talk to this layer
6	Presentation	Syntax for data conversion, makes session layer available to application layer.	ASCII, binary conversion, encryption and decryption, sockets
5	Session	Starts, stops and governs transmission order.	Sockets, synchronization
4	Transport	Ensures delivery of the completed message.	TCP, SNA, UDP
3	Network	Routes data to different networks. Forms packets.	IP, x.25, IPX, AppleTalk, Routing
2	Data Link	Transmits from node to node. Divides bits into frames.	Ethernet, Token ring, Frame Relay, Bridging
1	Physical	The connection medium. The hard, physical connection	RTS, CTS, RS-232, copper, fiber, wireless

Source: Dayton 1996, p. 3, orig. in ISO 1985

Layers 1 and 2 above characterize the primary foundation of the Internet. Originally, the regulated monopolies of telephone and cable companies controlled these segments of the market. As pointed out by Dayton (1996, p. 4), the past market structure and industrial organization has resulted in providers not keeping up with the vast amount of technological innovations in the upper layers. The result being, for example, that although consumer personal computers are now capable of processing bits at intense speeds, most users are still confronted with an Internet experience at a mere 28.8 kBits per second. The upgrading of these primary market segments will be an area of enhanced competition among future providers based upon deregulation efforts in the telecommunication carriers industry (as outlined in greater detail in Antonelli 1995 or the Survey of Telecommunications by Cairncross (1997)). Companies operating in layers 3 and 4 basically deliver TCP/IP packets throughout the network, culminating in customer services such as email, Usenet, ftp, Web, etc. offered by companies operating within layers 5 to 7.

Table 2: A random sampling of companies in each sector

Name	Hardware	Software	Access	Content	Services	Expertise
Application	Apple, Intel, Dell, Gateway	Netscape, Microsoft, Quarterdeck	EarthLink, Netcom, Sprynet, GNN	AOL, CompuServe, Prodigy, CNN, WSJ	Yahoo, Excite, Infoseek, Lycos	CKS, Digital, Planet, USWeb
Presentation	Sun, SGI, HP, IBM, DEC, Intel	Netscape, Microsoft, Interworld	EarthLink, Netcom, Sprynet, GNN, Best	AOL, CompuServe, Prodigy, BBN	Cybercash, CompuServe, BBN, I/Pro, Netcount RSA	CKS, Digital Planet, USWeb
Session	Sun, SGI, HP, IBM, DEC, Intel	Netscape, Microsoft, Interworld, Xing, Real Audio	EarthLink, Netcom, Sprynet, GNN, Best	AOL, CompuServe, Prodigy, BBN	BNN, CompuServe, I/Pro, Netcount	CKS, Digital Planet, USWeb
Transport	Cisco, Bay, 3Com, Wellfleet	FTP, Netmanage, Network Telesystems	Netcom, UUNET, PSINet, Concentric, MCI, BBN, Sprintlink	AOLNet (ANS), CompuServe, Sprintnet, BBN	BBN, CompuServe, Network Solutions	Anderson, EDS, Perot, BBN
Network	Cisco, Bay, 3Com, Wellfleet	FTP, Netmanage, Network Telesystems	Netcom, UUNET, PSINet, Concentric, MCI, BBN, Sprintlink	AOLNet (ANS), CompuServe, Sprintnet, BBN	BBN, CompuServe, Network Solutions	Anderson, EDS, Perot, BBN
Data Link	USR, Ascend, Cascade, Stratacom, AT&T	NorTel, AT&T	MCI, TCI, Sprint, Worldcom, AT&T	MCI, TCI, Sprint, Worldcom, AT&T	MCI, TCI, Sprint, Worldcom, AT&T	Anderson, EDS, @Home, AT&T
Physical	USR, Ascend, Cascade, Stratacom, AT&T	NorTel, AT&T	MCI, TCI, Sprint, Worldcom, AT&T	MCI, TCI, Sprint, Worldcom, AT&T	MCI, TCI, Sprint, Worldcom, AT&T	Anderson, EDS, @Home, AT&T

Source: Dayton 1996, p. 6

The Internet industry may alternatively be subdivided into *sectors* as in table 2 which classifies the various products and services available on these network layers. Currently, the Internet has six market sectors (Dayton, 1996):

1. Hardware

2. Software
3. Access
4. Content
5. Services
6. Expertise.

Although one may find company cases of overlapping onto different layers in more than one sector, commonly businesses focus their efforts on one or two layers in one sector only.

The OSI model suggests that companies may be more successful if they generally restrict their main operations to activities involving the layers immediately above and below their general lines of business. Expressing this somewhat differently, it may be argued that "...complications in developing and deploying networks and network-based products are directly proportional to the number of layers involved. Conversely, the fewer the layers involved, the simpler and more reliable the networking technology" (Dayton 1996, p. 7).

The economic trade-off on the other side of the coin, however, is that *as the technology becomes more complex and involves additional layers of the Internet a level of greater flexibility and value-added may be achieved.* It is important for companies wishing to position themselves competitively in the Internet market to comprehend the versatility effects of the multiple layers of the Internet. There are plenty of examples of companies such as AT&T's advance into computer hardware and online services, or USWest's interactive video services and MCI's consumer Internet service that have ended as financial disasters. Of new interest here is also the fact that telecommunications and Internet services are commencing to be traded internationally. Normally, the point of production and the point of consumption of a service activity fall together. As international competition increases, however, dumping of telecommunication services may be observed accompanied by an emerging "novel sort of trade war" (Cairncross 1997, p. 4).

Also, as the number of providers increases and new innovative technologies transform the segmentation of the Internet industry creating new industrial boundaries due to collective goal setting between governments and industry in pursuit of market shares, the future regulatory role of the government interface will have to be reconsidered and newly defined (Auster 1990, Gilroy 1998). In Germany, for example, new entrants are often owned by big industrial entities: debitel, which offers mobile-telephone services, is owned by Daimler-Benz (automotive industry) and by Metro (retail industry). Founded in 1992, debitel has already captured 17 percent of the German mobile market, "...partly by pioneering novelties such as marketing through Mercedes-Benz dealerships and offering a hotline for commuters to reserve parking spaces" (Cairncross 1997, p. 6). The constituent parts of such alliance groupings often have valuable knowledge and experience in manipulating different kinds of government regulatory systems.

Another illustrative German example are the private-sector regional energy monopolies such as Veba, Viag, and RWE who are now positioning themselves to compete with Deutsche Telekom. It may be the case that new models of regulation will be needed to deal with such changes. It has already even been suggested to contract out more regulatory tasks to the private sector. "Why not allow a global accountancy firm such as Price Waterhouse or Arthur Anderson to monitor compliance with licenses, for instance, or even to set up procedures for resolving those dreaded disputes about interconnections? The regulators might then confine themselves mainly to setting the rules in advance – which would inspire confidence among investors" (Cairncross 1997, p. 18).

The exchange of data and access to information are not the only fields of economic activity the Internet has to offer. It is becoming increasingly important for businesses to have access to this new media for a variety of reasons such as promoting the corporate image or facilitating business transactions by implementing the online network technology. Online network technology permits, for example, a relatively low-cost monitoring mechanism of economic and political developments in countries targeted by location decisions of multinational enterprises. As such, electronic networking in multinational enterprises may enhance world productivity (Gilroy 1993, Maloff 1995).

4 Economic Issues and Concepts of Internet Economics

After having examined some of the institutional and technological characteristics of the Internet industry in the above sections, the purpose here is to highlight some of the key economic issues and concepts of Internet economics. The literature on Internet economics, although still in its infancy, is already overwhelming. Consequently, the topics discussed here will be highly selective. For more detailed sources of valuable references on Internet economics the interested reader is referred to take a look at the extremely helpful bibliographies by Klopfenstein (1997) and Economides (1998a).

McKnight and Bailey (1997, p. 3) suggest that an economic model of the Internet must identify and include the following aspects:

1. Policy: the Internet promotes *interoperability* so different telecommunication infrastructures can converge and share services.
2. Economic: *network externalities* are realized when the membership of a network grows.

3. Technical: unused network resources like bandwidth and servers should be allocated to users who demand services so there can be equitable *statistical sharing* of resources.

They point out further that since the Internet supports heterogeneity there is necessarily a lacking of a "common metric of analysis". The challenge, in their opinion, is to develop economic models capable of handling the incorporation of the mentioned aspects.

The goal of economic public policy, as usually argued, is to maximize economic efficiency which has three components: (1) allocative efficiency; (2) productive efficiency; and (3) dynamic efficiency (Economides 1998b). Allocative efficiency requires goods and services to be sold at prices close to production costs. Productive efficiency demands that goods be produced in the most efficient manner possible. Dynamic efficiency compels innovation and growth maximization. The important economic insight here is that generally, these goals may be in conflict, leaving no "optimal" policy solution that maximizes all of them simultaneously. The dynamics of the Internet industry suggests that simple static models of economic analysis as known to date may miss the essence of the market and lead to social losses if prematurely applied for public policy before we have a deeper understanding of where the Internet is going.

If the Internet is to become the *Information Superhighway* of the future it will depend upon providing *network connectivity or interoperability* to users. As illustrated in figure 1 below, networks are composed of links that connect nodes. Internet Service Providers (ISPs) are in the rapidly emerging business of providing network connectivity to users. Since many components of a network are necessary for the provision of a typical service, network components are often complementary to each other.

Decreases in the costs of transmission due to new technologies such as fiberoptic lines, satellites and sinking switching costs along with steadily falling prices of microchips and integrated circuits have transformed the telecommunications industry from a natural monopoly to an oligopoly (Economides 1997, p. 6).

An important economic issue with regard to interconnection is *resale*. New entrants either have to build their own networks; or they can offer their services across the incumbent's network, paying it a fee. Naturally, by reducing their own service pricing schedule existing companies such as Deutsche Telekom may deprive potential new entrants of the margin needed to warrant the construction of their own networks. Such a *limit-pricing strategy* of an established firm and one possibly with high preentry capacity levels can discourage entry and slow down the level of industry innovation (see e.g. Tirole 1990, p. 367ff.). Since networks exhibit positive consumption and production externalities, new entrants may be more or less forced to deal with the dominant national telecommunications carrier. It has been pointed out that, "Almost every new entrant complains that the interconnection charges bear no relation to their true cost. Many grumble that interconnection charges account for around 40% of their operating costs" (Cairncross 1997, p. 14).

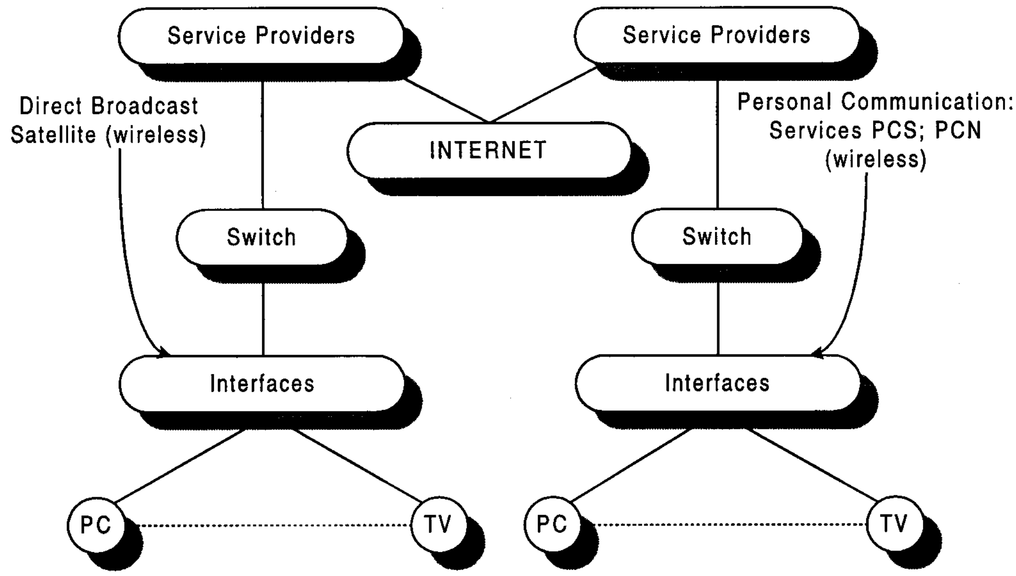

Figure 1: An information superhighway
(Source: Economides 1997, p.2)

Let us take a brief look at the logic of the "dominant firm model" and the reason for a limit-pricing strategy. Assume that the industry consists of many relatively new small firms and one large dominant firm. For example, the German Deutsche Telekom or the American AT&T and their rivals in the interstate telecommunications industry. Even though Deutsche Telekom or AT&T may no longer be technically a pure monopoly, monopoly power may exist given that one firm is dominant and a competitive fringe exists (Solberg 1992, pp. 574ff.).

The essential operational assumption of the dominant firm model is that, without regulation, the dominant firm can set the price and allows the follower firms to sell as much output as they wish at this price. Thus, the minor firms act as price-takers, whereby the dominant firm creams off the remaining part of the market demand. Given that the follower firms can sell as much as they wish at the price established by the dominant firm, they are faced with a horizontal demand curve and perfectly competitive situation. The follower firms view the dominant firm's price as their marginal revenue, and profits are maximized where their marginal cost equals marginal price. This may be illustrated by figure 2.

In figure 2 the industry demand curve is D. $\sum X_j$ represents the sum of the individual supply of minor firms. This curve is *not* to be interpreted as the market supply curve. Instead, the $\sum X_j$ curve characterizes that part of the market supplied by minor firms. Minor firms sell their output so that at any price the common pricing rule, price equals marginal cost, is valid. The dominant firm now supplies the remainder between market demand and the quantity supplied by the minor firms. The dominant firm's average revenue curve AR_d is obtained by subtracting the quantity supplied by the minor firms from market demand.

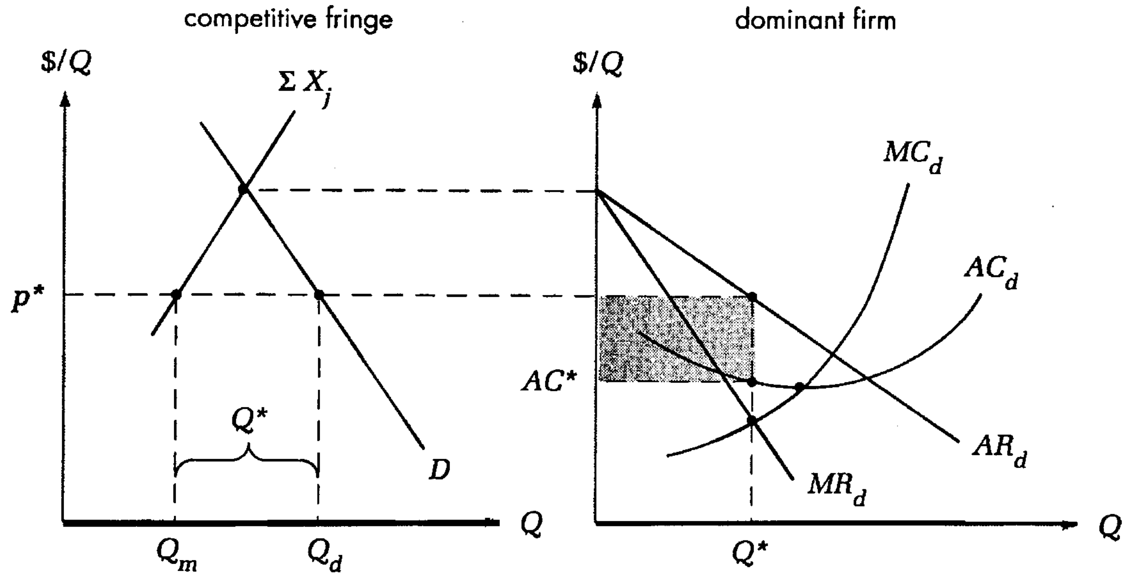

Figure 2: An industry with a dominant firm
(Source: Solberg 1992, p. 575)

At or above price p_0, the minor firms supply all the quantity demanded. At prices beneath p_0, the minor firms supply the part of the market demand determined by their marginal cost curves. The dominant firm supplies the remainder. In accordance with the cost curves AC_d and MC_d , the dominant firm now sets price at p*, where $MR_d = MC_d$, with output at Q*. The minor firms view price p* as constant to them and collectively supply the quantity Q_m. Total units supplied equals Q_m + Q*, which equals the quantity demanded Q_d, and the market is in equilibrium at price p*.

In the short run, this solution appears stable. According to Cairncross (1997, p. 9), "...the new entrants usually nestle in under the lee of the giant, making a tidy living, but ensuring that their hefty rivals does so too. Over time, the new entrants will help to drive prices inexorably towards costs. But for the moment, look at them as a source of new marketing ideas and new technologies, rather than aggressors in a price war that might well destroy them." However, if the price set by the dominant firm leads to economic profits for the minor firms, potential new entrants will emerge. Additionally, if there are economies of scale present, minor firms will wish to expand their operations. This will shift the dominant firm's AR curve to the left, decreasing the market share and profit of the dominant firm. Consequently, public regulators are faced with the problem of finding an answer to the question: “how do they give the incumbent an incentive to co-operate while still allowing new entrants to make money?” (Cairncross 1997, p. 13).

A second important concept in Internet economics is *network externalities* (see. e.g. Liebowitz & Margolis 1995). The fundamental reason for the emergence of network externalities is the complementarity between the components of a network. Expressed somewhat differently, network industries reward size. The more economic agents connected to a network, the greater the value of being part of the network. A telephone or fax machine, or even a credit card, is basically worthless unless it is plugged into or accepted in a (globally) interconnected network. The value of a telephone or fax machine increases with the number of *expected* units installed. The demand curve slopes downwards but shifts upward with increases in the number of units expected to be installed (Economides 1997, p. 6).

Such positive network externalities emerge when a commodity is more valuable to a user the more users adopt the same commodity. Such externalities may be *direct network externalities* as in the case of a telephone network with n subscribers, the addition of the $(n + 1)^{th}$ subscriber allows for $2n$ additional types of calls to be made (from the new subscriber to all old subscribers and vice versa). Or the externality can be an *indirect network externality* based upon increasing returns to scale in production, so that a greater variety of complementary products can be supplied at lower prices when the network grows. Such “virtual networks”, as Economides (1997, p. 1) terms them, arise when two complementary components are required to make a valuable good or service. Typical examples are the combination of a computer operating system and applications software that run under the operating system, video cassettes compatible with a dominant video system, or a popular automobile being serviced by more dealers. The size of a relevant network may be firm-specific as in the car dealership case, or industry-wide as in the cases where technical hardware standards are important.

Users on the demand side of a market affected by network externalities, due to their *interdependent utility functions*, must attempt to anticipate which technology will be widely used by others. Consequently, difficult coordination problems founded upon conflicting consumer preferences and technologies commonly emerge. Such coordination problems often lead to two inherent inefficiencies: *excess inertia* (users postpone adopting a new technology) and *excess momentum* (consumers rush to an inferior technology for fear of getting stranded).

On the supply side, given the presence of network externalities, standards (i.e., a choice of a particular technology to be adopted by all) are often mandated by the government or by private bodies such as industry committees. On both sides, actions by firms and consumers to adopt various technologies give rise to product diversity games of timing. The two polar cases of which are wars of attrition and preemption games (see e.g. Tirole 1990, chap. 10).

Given the presence of network externalities, it may be shown that perfect competition is inefficient:

> The marginal social benefit of network expansion is larger than the benefit that accrues to a particular firm under perfect competition. Thus, perfect competition will provide a smaller network than is socially optimal, and for some relatively high marginal costs perfect competition will not provide the good while it is socially optimal to provide it. One interesting question that remains virtually unanswered is how to decentralize the welfare maximizing solution in the presence of network externalities (Economides 1997, p. 9).

The need for some form of welfare enhancing network price discrimination gives rise to the third major issue: *equitable statistical sharing of Internet resources.* McKnight and Bailey (1997) define equitable statistical sharing as the ability for networks to allocate bandwidth (transmission capacity) to users based upon the users' needs. Although much has been written about Internet pricing, this is still a relatively new area of research. To date, three common pricing models characterize the access debate and the scarcity of Internet transmission resources:

1. Flat-rate pricing: One rate is charged to the user regardless of actual use or type of connection.
2. Capacity-based pricing: Presently, many Internet users pay a fee to connect while they are not billed for each bit sent but are charged for different types of connections.
3. Usage-sensitive pricing: Users pay a portion of their Internet bill for a connection and a possibly varying portion for each bit sent and/or received.

Pricing questions extend, however, far beyond the market for Internet bandwidth and stretch out into more fundamental important areas as exploring new frameworks for rethinking patent and copyright laws in the Digital Age (Barlow 1994) or attempts at developing an economic model for the trade in free goods and services on the Internet (Ghosh 1998). Along these lines of thought a variety of complex and economically interesting questions emerge. For instance, as digital technology is increasingly detaching information from the physical dimension, how should "virtual" copyright and patent laws be designed. "If our property can be infinitely reproduced and instantaneously distributed all over the world without great cost, without its even leaving our possession, without our knowledge, how can we protect it?" (Barlow 1994, p. 84). How is it going to be possible to get payment for intellectual property rights on the Internet? And, if an efficient pricing mechanism can not be found, what will assure the continued creation and distribution of such information on the Internet? What are the economic essentials of unbounded information creation and missing or not clearly defined property rights?

It may be argued that in the past one did not get paid for ideas produced, but for the ability to deliver them into (physical) reality. That is, the economic value was in the conveyance and not in the thought conveyed. "In other words, the bottle was protected, not the wine." (Barlow, 1994, p. 84). Digital technology seems to be obliterating the legal jurisdictions of the physical world as we once knew it and replacing them with the unbounded and largely lawless waves of cyberspace with a new "Metabottle" expressed as complex and highly liquid patterns of ones and zeros. Governments will also have to further clarify liability for material conveyed on the Internet as recent public cases of the distribution of pornographic- and nazi-propaganda material over the Internet suggest.

What solutions will emerge to answer questions like "how to get paid in cyberspace?" Will there be a sort of compensating re-emergence of Internet ethics and accepted norms that successfully sanction the ordering template of society? Or will the future protection of your intellectual property depend on your ability to control your relation to the market? Barlow (1994) suggests that future control will probably be based on restricting access to the freshest, highest bandwidth information protected by a technological solution of cryptography ("Crypto Bottling", i.e. any purely technical method of property protection such as a decoder or encryption), as opposed to institutionalized ethics of some legal social contract defining property rights which inherently always will be hanging behind the developments of new technological innovations.

As already mentioned above, laws of increasing returns based upon familiarity is an important asset in the Internet industry. The best way to raise the demand for your product may simply be to give it away free. One is reminded of the historical strategy of the famous American oil magnate Rockefellar who distributed kerosene lamps free of cost to the Chinese, thereby creating an enormous demand for their complementary input kerosene produced from the oil of Rockefellar's refineries. The current antitrust proceedings against Microsoft is illustrative of a similar situation. The U.S. Department of Justice alleges that Microsoft is attempting to extend its monopoly of the Operating Systems market to the market for Internet browsers. Microsoft is providing its browser Internet Explorer free, i.e. it is alleged to be charging too little, not charging too much as usually the case in such monopoly legal battles. The apprehension being that as Microsoft spreads its dominance from one area of software to the next, Microsoft will stop innovating (see e.g. Choi, Stahl & Whinston 1997, Taylor 1998, Krugman 1998, Economides 1998d, and the online documentation of the latest independent information on the current Microsoft legal battle by Economides (1998c)). For a general discussion of the relevant aspects of competition policy on innovation confer further Langenfeld & Scheffman 1988). Basically, since it takes time and effort for a user to install a competing browser, Microsoft has an advantage (of raising rival's costs) if its browser is already installed by the PC manufacturer. Economic analysis demonstrates that a monopolist has an incentive to raise the costs of the rivals (Salop & Scheffman 1983) and to degrade the quality of the monopolized good, thereby generally reducing the level of industry competition and social welfare (see e.g. Economides 1998d).

Let us now briefly examine the fact that much of the economic activity on the Internet involves value but no money. The amount of freely accessible resources on the Internet still greatly outweighs all commercial resources at the moment. As pointed out by Ghosh (1998), it is basically impossible to put a price on the value of the Internet's free resources, at least in part because they exist because they do not have prices attached. They exist in a *market of implicit transactions*. The exchange of knowledge on the Internet is essentially an act of trade. What are the motivations of what Ghosh (1998) terms the "economics of gossip", i.e. the "free" distribution of operating systems such as Linux or Web server software, Newsgroups, HTML (the language of the web), mailing-lists and on-line chatting sessions? It may be argued that there is no specific economic inherent value in a product. Value lies in the willingness of economic agents to consume a good or service, and this potentially exists in anything that individuals can produce and pass on.

Internet transactions that are not based upon explicit price-tags, may still represent an implicit sales transaction. The involved agents are implicitly selling their work to purchase the work of others – e.g. in a discussion group – or to buy the satisfaction of popularity and enhanced reputation in the "attention economy" which may be convertible into currency or better access to things of value at a later date (Goldhaber 1997, Lanham 1997). "Without the intermediary of money, there are always two sides to every transaction, every transaction is potentially unique, rather than being based on a value derived through numerous similar trades between others – i.e. the price-tag. ...Life on the Internet is like a perpetual auction with ideas instead of money" (Ghosh 1998, pp. 5-6). Based upon the trade principle of reciprocity, i.e. the process of give and take,

"...the economy of the Net begins to look like a vast tribal cooking-pot surging with production to match consumption, simply because everyone understands – instinctively, perhaps – that trade need not occur in single transactions of barter, and that one product can be exchanged for millions at a time. The cooking-pot keeps boiling because people keep putting in things as they themselves, and others, take things out" (Ghosh 1998, p. 10).

5 Conclusion

The Internet industry is embedded in a complex and rapidly changing transactional environment in which firm-specific and industry-wide complementarities exist. As argued above, the challenge to any analysis of the Internet and public policy is that government and industry are not necessarily guided by tightly drawn boundaries. Rather, as technology has evolved, the fortunes and misfortunes of governments, producers, and consumers worldwide are becoming even more closely linked through the Internet. To a large extent Internet activities all consist of exchanges of information and collective goal setting while maintaining high levels of competition. As transactional relationships increasingly evolve on a global level, the effectiveness of the Internet will largely depend upon an awareness of the economic logic of network structures.

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