ECONOMIC ISSUES

Economic Perspectives on the Internet

by

Alan E. Wiseman

BUREAU OF ECONOMICS

FEDERAL TRADE COMMISSION

July 2000

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I would like to acknowledge the support of the Bureau of Economics and the Federal Trade Commission, and thank them for providing me with the opportunity to study this interesting topic. In addition, I would thank David Balto, Denis Breen, Jeremy Bulow, Gerard

Butters, Dan Caprio, Robert Cannon, Patrick DeGraba, Susan DeSanti, Sara Harkavy, Michael Kende, Robert Litan, David McAdams, Thomas Pahl, Paul Pautler, Robert Pepper, Simon Steel, Michael Vita, and Dean Williamson for helpful comments and suggestions on this project. Thanks also goes to Sara Harkavy (again), Morgan Long, and Melissa Oshfelt for excellent research assistance.

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Executive Summary

The information technology sector of the United States economy, spurred on by the expansion of the Internet, has undergone explosive growth. According to one estimate, in 1998 Internet-related industries led to the creation of over 1.2 million jobs and generated more than $300 billion in revenue. At the same time the Internet has expanded immensely. As of December 1999, it was estimated that more than 4.9 million commercial websites had emerged, and in the closing months of the year, that number was increasing at a rate of almost 500,000 per month. The rapid growth of the "Information Economy" has drastically changed the manner in which commercial transactions are conducted, as anything from material goods (such as books) to information goods (such as databases) can be procured with the ease of a mouse click. This report investigates the underlying economics of certain facets of the Internet. By examining recent literature addressing economic aspects of the Internet and electronic commerce, as well as more traditional literature on pricing practices and market structure, this report will serve as a roadmap of the current terrain in Internet-related economic matters, as well as a framework for future analysis.

The report covers five primary areas of inquiry. The first section provides a brief technical overview of the Internet and discusses the transmission technologies employed. What is currently known as the "Internet" is a descendent of federally-funded research that began in the Department of Defense in the early 1960's and was maintained by the National Science Foundation until the mid 1990's. Unlike telephone networks where conducting a call requires a dedicated circuit for the duration of the transmission, information is sent across the Internet via packet-switching technology that breaks the transmission down into data "packets" of approximately 200 bytes and sends them from origin to destination. While traveling from end to end, the packets may traverse several different computer networks, and the Transmission Control Protocol/Internet Protocol (TCP/IP) helps facilitate the arrival and reassembly of all packets at their destination. High levels of user activity can lead to congestion on the network, which might slow down, or prevent, packet transmission. No centralized authority governs the Internet, but several industry consortiums and volunteer nonprofit groups help devise standards for interoperability. For the matter of domain name assignment (assigning the proper names for webpages), Network Solutions Incorporated (NSI) currently maintains control over the domain name registry.

The second section of the report discusses different methods employed and theoretical models proposed for pricing user access to the Internet. The most commonly used method is known as flat pricing, where users pay a flat fee to have unlimited access for a fixed period of time (e.g., per month). While flat pricing is very convenient in that it simplifies accounting issues, certain economic properties may make it less than optimal. First, the flat price does not induce users to take into account the congestion costs (an externality) that they impose on other users during peak periods, which can lead to further network congestion. Second, the flat price cannot discriminate between "high" and "low" priority applications, leading to cases in which those who value services the most are not receiving them. To address these problems, several alternative models of access pricing are being studied. The auction approach would require users to attach bids to each packet they submit to the network, and any bid above the market clearing price (as defined by the network's congestion constraints) would be transmitted. Static and dynamic priority pricing models present users with a menu of applications, which vary in price as a function of the priority level the user attaches to the application in question, which will designate its place in line should network congestion occur. Finally, the Paris Metro Pricing model partitions the network into subsections and charges different prices for access to each subsection; users will sort themselves into divisions depending on their willingness to pay, leading to an efficient allocation of network resources. With the impending growth of Internet usage, in the absence of some sort of technological change and/or pricing policy change, it is possible that the quality of service associated with a flat-pricing regime will deteriorate. Among the technological alternatives being considered is capacity expansion, "caching", and new protocols to facilitate differentiated service levels. The pricing models proposed might succeed in alleviating congestion, but as of yet, none have been widely implemented in a real-world setting. Future research might aim at testing these various models against each other, either through simulations or in experimental settings, to determine which options perform the best in managing congestion.

The third section of the report examines economic issues surrounding pricing of goods and services on the Internet. Theory might imply that a reduction in the costs of transactions will lead to lower prices, less price dispersion, and frequent price adjustments by online firms in comparison to their offline counterparts. Early empirical analysis offers mixed support of these hypotheses; in the markets for books and compact discs, prices seem to follow these trends, but these findings do not hold across all markets. Because the Internet environment facilitates easy (and costless) reproduction of information goods, theory might lead us to believe that one should expect to see many products and services being packaged together and sold as bundles. While there are efficiencies to be gained from such ventures, there are also possibilities that such activities might stifle innovation and deter entry of potential competitors into the market. The utilization of technologies that allow firms to monitor surfers' travels across the Internet present numerous opportunities for price discrimination and product customization. The use of electronic agents known as "shopbots" may lead to lower prices which benefits consumers, but may also have the effects of adding to Internet congestion and facilitating industry collusion. Theory and preliminary empirical analysis suggests that regardless of the reduction in transactions costs, there will still be a need for institutions that can provide product expertise and vouch for firm reputations on the Internet. Future research might study the robustness of price differences between online and offline firms across additional markets, the prospects for collusion in electronic markets, and the manner in which the Internet serves as a clearinghouse for second-hand durable goods.

The fourth section of the report examines the role of network externalities in the development of the Internet, and how such effects might affect firms' activities. A good is commonly referred to as possessing network externalities if the value of the good to an individual user increases as more individuals use it. Given that the Internet, by design, is a "network of networks", one would suspect that conventional economic principles should apply to much of its underlying mechanics. Theory implies that in network industries, a consumer's choice of a given technology depends directly on their perceptions about the likelihood of that product’s dominance. Once a technology has attracted enough users, it is said to achieve “critical mass,” after which it can survive as a viable product, and possibly be the dominant standard. In trying to achieve critical mass, firms might employ various strategies, such as low introductory prices, aggressive advertising, etc., in the hopes of attracting consumers as quickly as possible. On the Internet, network externalities arise in considering network interconnection agreements between Internet service providers, as well as in considering standards adoption by emerging technologies such as digitized media. The ownership of an (arguably) essential facility, such as an Internet backbone, may allow large Internet service providers to squeeze rents from those firms that require interconnection to conduct business. In establishing new standards, there is the potential for excluding competitors from the standard, who may then be harmed because of their incompatiblity with the existing network. Furthermore, in trying to achieve critical mass, some of the strategies employed by firms may be viewed as anticompetitive. At the same time, standards can obviously benefit consumers in that they expand the size of the network. Future research might aim at uncovering the differences between market power that arises from normal competition versus market power that arises from anticompetitive exploitation of network externalities.

The final section of this report considers the issue of taxation of Internet commerce. There is a debate ensuing between the proponents and opponents of online taxation. Those in favor of effective collection of existing sales taxes on the web cite economic research arguing that such taxes are necessary to ensure that the sales tax system is not distortionary, as well as ensuring that state and local governments will not lose sizable revenues as more consumers migrate to the Internet. Those opposed to Internet taxes claim that mandating such taxes will place a large burden on retailers who would likely be required to collect and remit the taxes, as well as stifling the growth of electronic commerce. The existing empirical research has focused on estimating the likely effects of instituting Internet taxes with respect to consumer activity, state revenues, and the level of compliance costs. With respect to consumer purchasing patterns, early analysis has shown that those who live in areas with high sales taxes purchase more often online (and actually buy more) than those who do not; hence, implementing current sales taxes online would likely decrease online purchases. It does not appear currently that governments are losing a sizable portion of their revenues to the web. Finally, there is empirical evidence to suggest that smaller businesses would bear the burden of collecting and remitting sales taxes more so than larger businesses. While the empirical evidence might offer a modicum of support to those who oppose taxation, the Internet as a transactions medium is immature, and further research, studying sales, rates of Internet diffusion, and revenue streams of local governments and bricks-and-mortar stores, is necessary to determine if these findings are representative of a long-run stable outcome.

Economic Perspectives on the Internet

Alan E. Wiseman

Introduction

The information technology sector of the United States economy, spurred on by the expansion of the Internet, has undergone explosive growth. According to a recent study by the University of Texas at Austin and Cisco Systems, the "Internet Economy" has led to the creation of over 1.2 million jobs, and generated over $300 billion in revenue (Barua, et al. 1999). In terms of user base, recent estimates project that by the end of 2000, 72 million Americans will have access to the web--up from 14.3 million in 1995 (Atkinson and Court 1998). The Internet, by all accounts, has drastically changed the manner in which business is done. Anything from material goods, such as groceries and compact discs, to information goods, such as database access and newspaper text, can be acquired with the ease of a mouse click or key stroke.

The ease with which goods and services are purchased has corresponded to a dramatic expansion of web-based businesses, known generally as electronic commerce. One source has estimated that there were over 4.9 million commercial websites, as of December 1999, and that the number of commercial websites was growing in the last months of the year at a rate of almost 500,000 per month.[1] This proliferation of commercial websites, as well as the potential profitability associated with such ventures, has motivated entrepreneurs to attempt to carve out niches in this new marketplace. Their activities have, in turn, also drawn attention from the legislative, executive, and regulatory arms of the government as they seek to understand this new medium, and its potential for both growth and misuse.

[1] The term "commercial" website refers specifically to those websites that have a ".com" suffix. If one includes those commercial sites that use a ".org", ".net", or other suffix, then the number would be substantially larger. Estimates from: http://www.netcraft.com/survy/Reports.

A common question being voiced is: "What is the 'Information Economy'?" While it is easy for media commenators to claim the Internet has spawned a revolution that will redefine virtually all economic and societal relationships, as an economist, one might critically wonder what this "digital revolution" will mean for government enforcement policy.[2] Does this new technology require economic practitioners to actually consider new theories in order to understand the internal workings of the digital market? Or is it the case, as Shapiro and Varian (1999) have argued, that "a few basic economic concepts go a long way toward explaining how today's industries are evolving."

This essay will discuss some of the recent literature dealing with the economics of the Internet, focusing on the subjects of pricing of access to the Internet, pricing of goods sold via the Internet, network externalities, and Internet taxation. It attempts to present a succinct picture of the relevant literature, and offer some thoughts about the future development of the Internet, with respect to competition and consumer welfare. While none of the topics is covered in complete detail, this paper will hopefully provide the reader with enough information to serve as a roadmap of the current terrain in Internet-related economic matters, as well as a framework for future research endeavors.[3]

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[2] A recent report by the International Competition Policy Advisory Committee (International Competition Policy Advisory Committee 2000) noted several possible threats to competition, such as cartels and price signaling, that might follow from the expansion of E-commerce. While not offering any specific policy recommendations, the committee urged governments to be very attentive to the ongoing development of the e-marketplace, and to be ready to respond with appropriate antitrust enforcement measures.

[3] The topics covered in this essay were selected for investigation primarily because of the sizable body of existing (and relevant) economic research. A non-exhaustive list of additional Internet-related topics might include commercial fraud, electronic payment systems, security and privacy of Internet transactions, copyright protection, and advertising strategies. For a treatment of several of these subjects, the interested reader is referred to Choi, Stahl and Whinston (1997).

Section 1 will present a brief, relatively non-technical analysis of the current state of the Internet to help readers familiarize themselves with the technologies being discussed in subsequent sections. Section 2 will discuss current pricing practices for providing Internet access, as well as theoretical possibilities that have yet to be implemented. Section 3 will consider how the environment of the Internet, especially with respect to relatively low search costs and a variety of easy-access information, will shape the pricing of goods and services sold online. Section 4 will consider the network externalities literature and note how these theoretical models of network creation might apply to the current state of the Internet. Section 5 will move beyond theoretical and empirical studies and address a topic that has generated significant attention in the public as of late: taxation of online commerce. Finally, Section 6 will conclude with some general comments and a discussion of possible future areas of study.

Section 1: What is the Internet?

This section will present a very brief historical sketch of the technological development of the Internet.[4] Particular attention will be drawn to the relevant transmission technologies (packet switching versus circuit switching), as these factors will be especially relevant to the sections on pricing of access and network externalities.

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[4] The term "Internet", as used in this paper, refers to an open network. More specifically, the Federal Networking Council (FNC) has defined the Internet as follows: "the global information system that—(i) is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions/follow-ons; (ii) is able to support communications using the Transmission Control Protocol/Internet Protocol (TCP/IP) suite or its subsequent extensions/follow-ons, and/or other IP-compatible protocols; and (iii) provides, uses or makes accessible, either publicly of privately, high level services layered on the communications and related infrastructure described herein." (FNC Resolutions: Definition of "Internet", 10/24/95, http://www.fnc.gov/Internet_res.html). In contrast, the web is an application that runs on that network.

1.1 History and Origins

The technology that is currently referred to as the "Internet" can trace its origins back to the early 1960's when a division of the Department of Defense, ARPA (Advanced Research Projects Administration), developed the predecessor to the Internet, ARPAnet, to link together universities and high-tech defense contractors.[5] In October 1969, a message was successfully transmitted between research centers at UCLA and the Stanford Research Institute in Northern California, and the Internet was effectively born. Government involvement in the evolution of the Internet continued into the 1980's when the National Science Foundation (NSF) created NSFNET to serve as a "backbone" that would connect the NSF-funded supercomputer centers. The NSFNET evolved to serve as a backbone network to which several smaller regional networks, and their supported local area networks (LAN) connected themselves. Around the same time, several private Internet backbones began to emerge, providing access to private networks in a manner analogous to NSFNET. In 1994, there were three privately funded backbones in the United States besides NSFNET: Alternet, PSInet, and SprintLink. With the success of these privately funded ventures, the federal government withdrew from backbone provision in 1995 when NSF funding for NSFNET expired. Although federal funding of NSFNET expired, the NSF helped coordinate the development of interconnection points between backbones, known as Network Access Points (NAPS), which are currently being administrated by private entities.[6]

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[5] One of the original motivations for ARPAnet was to devise a communications network to link together the branches of government that would be highly resistant to the destructive effects of war. Given that information is transmitted via packets, rather than closed circuits, on the Internet, even if certain telephone networks were destroyed, communications would most likely still be possible, as packets would find whatever pathways were still available upon which to travel (Tapscott 1996, pp. 17-19).

[6] For more detailed information on the history of Internet development, as well as further technical details, see Esbin (1998), Krol and Klopfenstein (1996) MacKie-Mason and Varian (1997), and Oxman (1999). Galla (1998) provides a relatively non-technical introduction and explanation of recent Internet technologies, and Greenstein (1999) provides a history of the Internet Service Provider market. Interested readers might also consult the Internet Society's

1.2 Basic Technology and Infrastructure

Given that there is no central authority, and it is composed of several components connected by an open communications standard, the Internet has commonly been referred to as a "network of networks".[7] While such a characterization might imply a lack of organization, the infrastructure is still organized in a relatively straightforward hierarchical manner consisting of backbone providers, regional networks, and Local Area Networks (LAN).[8] At the highest level of the infrastructure are the backbone providers. Using the analogy of a road system, a backbone can be thought of as an interstate highway, stretching from one side of the nation to the other; and to which smaller intrastate highways are connected. These smaller intrastate highways are analogous to regional networks, connecting individual city roads to the interstate highway. Finally, at the lower level, the LANs, such as those utilized on a university campus, are analogous to the city/country roads, where a given traveler might begin his journey from point-to-point.

The road system analogy is especially appropriate for characterizing the Internet if one considers how information is transmitted. Unlike conventional telephone networks, which employ circuit-switching technology, the Internet operates by utilizing a packet-switching technology. The term "circuit-switching", implies that for two customers to make a phone call, a circuit must be established between them, and remain open, for the entire duration of the call--even in periods of dead silence. In highway terms, circuit switching would be analogous to closing off an entire lane of the interstate for a person who wanted to send a dozen roses between

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webpage on "Internet Histories" that includes hyperlinks to several other historical accounts of the development of the Internet: http://www.isoc.org/internet/history/index.shtml.

[7] This is not to say that no organizations exist that oversee Internet development. As will be discussed below, numerous voluntary groups have emerged to assume various roles.

[8] This three-tier characterization is discussed in greater detail in MacKie-Mason and Varian (1997).

San Francisco and Washington D.C., and not opening the lane until the flowers were delivered.[9] The Internet, by contrast, allows communications to occur by transmitting data between users in small "packets", usually consisting of approximately 200 bytes. Sending these packets does not require a dedicated circuit, and packets from other users can be sent on the same pathway contemporaneously. Employing the highway analogy again, packet switching is analogous to breaking up the dozen roses into individual flowers, carried by twelve cars, and sending them on the interstate to get to their end destination as quickly as possible, where they are reassembled into one complete package. The time of delivery, of course, would depend upon the quality of the road, and on the amount of traffic caused by other cars in transit.

In trying to send information across the Internet, two questions might seem pressing: how is the information broken down into packets, and how are the packets reassembled? The technology that allows such data transmission to occur is known as the TCP/IP protocol. When a user at a given terminal sends data off on the Internet "highway", (e.g., email message, web page, etc.), the first thing that occurs is that the message is broken down into packets by the Transmission Control Protocol (TCP). In creating a packet, the TCP attaches a "header" to the packet that specifies how the packets will be recombined upon arrival at their destination. Once the packets are created, the Internet Protocol (IP) specifies address information for each packet that determines where it will go next on its journey between points. An IP address is a series of four numbers, each ranging from zero to two-hundred-fifty-five, separated by periods (dots), which represents the "mailing address" of the computer to which the content is being sent.[10] Between origin and terminal destination, the packets might traverse several computer networks,

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[9] For the sake of illustration, the author requests that readers disregard the option of teleflorist services.

[10] All email addresses and web pages have a corresponding unique IP address. Conventional email addresses and web page names (e.g., awiseman@ftc.gov, http://www.ftc.gov) are only used as convenience for memory. Upon sending email, or requesting a web page, a name server translates the email address/web page name into its corresponding IP address to determine where precisely, the message is going on the web. For example, the home page of Stanford University, http://www.stanford.edu has the IP address of: 171.64.14.237.

analogous to interstate (backbone) and intrastate (regional network) highways. At each junction between networks, a "router" will examine the packet and its IP address, and then determine where to send the packet next in order to manage traffic most efficiently. Finally, the packets will reach their terminal destination and the TCP will reassemble them into the original content.

While the above process might seem simple, user activity can easily complicate matters, as congestion on the network can severely inhibit delivery time and performance. Most networks do not currently employ any method to determine priority classes with respect to packets. This is not a problem in low-traffic periods where congestion is negligible and packets are sent practically instantaneously. In periods of high traffic however, packets enter a queue and are usually sent in a first-in-first-out manner (FIFO), possibly leading to some packets being substantially delayed or discarded altogether. In the case of dropped packets, further delay can ensue as the TCP, in an attempt to relieve congestion, may reduce the rate at which packets are sent.[11]

1.3 Governance Structure

As noted above, at this time no centralized authority governs the Internet. While the infrastructure is continuously being developed through a combination of public and private investment, different portions of the network are run essentially independent of one another. Industry consortiums and volunteer nonprofit groups such as the World Wide Web Consortium (W3C), the Internet Engineering Task Force (IETF), and the Internet Corporation for Assigned Names and Numbers (ICANN) have emerged in recent years to help devise universal standards for interoperability, but none of these bodies possess any sort of de facto lawmaking power that

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[11] New technological developments have helped to ameliorate congestion problems even absent any sort of market rationing of access. Introduction of "broadband" Internet services through either cable, satellite, or conventional copper telephone lines (DSL), have enabled consumers to surf the web at much higher speeds. Of course, as the Internet becomes increasingly popular, these technologies, too, may eventually experience congestion problems absent any sort of rationing mechanism. Kopel (1999) provides a detailed overview of current broadband technologies.

can create general rules for web "etiquette". A matter that is being dealt with by one of these consortiums, and has recently attracted significant attention, is domain names registration. A domain name is the term given to the proper name assigned to the IP address of a webpage (e.g., www.washingtonpost.com). Network Solutions Incorporated (NSI) of Herndon Virginia, currently maintains the domain name registry.

NSI held a virtual monopoly over registering websites ending in several suffixes including .com, .edu, and .net as the result of a contract awarded to it by the United States Department of Commerce in 1992. Anticipating the expiration of NSI's monopoly in 1998, the Clinton Administration charged (ICANN) with trying to assess the most efficient manner to manage the domain name registration process once NSI's contract was terminated. Following a year of negotiations, an agreement was hammered out between the Department of Commerce and NSI in September 1999 that paved the way for open competition in domain name registration. Under the agreement, NSI would make a one-time grant of $1.25 million to ICANN to help cover their administrative fees, and formally recognize that ICANN had administrative authority over domain name registration, while NSI would retain control over the domain name database until 2003 (at which point a successor registry, possibly NSI, would be designated).[12] In aiding competition, the agreement opened up the way for other firms to handle domain name registration, providing that they paid a six-dollar-per-name fee to NSI to have the new name entered in NSI's database.[13]

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[12] The agreement did not specify the process by which ICANN would designate the new registrar, but the agreement did provide NSI with financial incentives to withdraw from the registration business (Kaplan and Schriver 1999). If the registry was sold to another company in the first eighteen months after the agreement was ratified (which occurred in November 1999), the purchaser of the registry would have administrative authority over domain names for an additional four years after 2003, (thereby increasing the sale price, other things being equal). For more information on the agreement, see http://www.icann.org/nsi/nsi-registry-agreement.htm.

[13] NSI also registers domain names themselves, charging anywhere between $35 and $169, depending upon the registration options desired (e.g., length of registration, listing in a directory, etc.). In a response to a Request for Comment (RFC) by the National Telecommunications and Information Administration, Vita and Horne (1998) provide a technical overview of domain name assignment as well as the competitive implications of the breakup of NSI's monopoly over assignment power. For more information on the development of Internet

The explosive growth of the web combined with lack of central authority has raised some serious questions about the appropriate role of government (federal or otherwise) in managing the web. Industry leaders have argued that the Internet, in both electronic commerce matters and otherwise, should be managed by various methods of self-regulation on the part of the private sector.[14] Various advocacy groups, however, have pressed for government involvement in managing the web on issues ranging from privacy to access provision, to sales tax. Regardless of what role the federal government adopts in the future, the topics addressed below are most likely to be among some of the more relevant issues that will be brought to the forefront of the policy debate.

Section 2: Pricing of Access to the Internet

The Internet is an interesting environment with respect to user activity, in that for a given user, his preference regarding the number of network users is somewhat mixed. As more consumers and businesses begin using the Internet, the value of the network to any given user increases. This positive trend is not constant however, as it only continues until the point where the congestion caused by additional users on the system leads to a degradation in service, either because of excessive delay, or loss of services altogether.[15] The explosive growth in the number of web-users, combined with the increased use of data-intensive applications (e.g., streaming audio, video, etc.), has raised questions about how best to manage Internet traffic in order to ensure high levels of service quality. Several technological innovations have been suggested to address potential congestion problems. In addition to technological changes, much scholarly

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governance and domain name assignment, see Gillet and Kapor (1997), Shaw (1997), Gigante (1997), and Oppendahl (1997).

[14] In a recent study, Oxman (1999) has examined how the private marketplace and minimal government intervention has allowed the Internet to thrive in various ways.

[15] Economists would argue that such preferences are indicative of the concavity of a user's utility function over network activity.

attention has been directed towards devising some sort of distribution system, relying primarily on pricing mechanisms, which can provide an efficient utilization of network resources. In the following section several theoretical pricing options will be discussed.

Taken together, these pricing models represent an interesting combination of traditional microeconomic theory and more recent computer science, and they range from very simple methods, such as flat pricing for access, to significantly more complicated approaches, such as conducting auctions over individual packets. In this section, several of these approaches will be discussed in detail.[16] After investigating the models, we will consider other, supply-side, alternatives to pricing models that might facilitate efficient Internet traffic, and conclude with a brief discussion of other public policy aspects of access provision.

2.1 Flat Pricing

The most common method currently used for access to the Internet is flat pricing. Under this scheme, users pay a flat fee, usually monthly, which allows them to have unlimited access to the Internet at a particular service level. For example, one might pay $19.95 a month to be connected to an Internet Service Provider (ISP), which allows the customer unlimited use at whatever speed the modem pool of the ISP supports. Flat pricing essentially offers "best effort" service for all users. When the network is uncongested, there is negligible waiting time and all information is transmitted instantaneously. When there is a high level of usage, however, flat pricing cannot discriminate between users, and all customers are subject to the same level of delays and loss in service quality.[17] In some applications, delay in transmission might have little

[16] The approaches discussed here are not meant to be an exhaustive list off all methods being considered, but rather a sample of the relevant microeconomic research that is investigating the issue of alleviating Internet congestion. For additional examples and references, see McKnight and Bailey (1997).

[17] This does not imply that other pricing systems would fail to provide "best effort" in terms of the transmission path chosen and guarantee of delivery. Rather, it means that other pricing mechanisms, in differentiating between packets, could possibly provide those users who pay higher prices with a higher quality of service than that which they receive when all packets

effect (e.g., email); but, applications such as real-time video or audio streams can suffer greatly due to delayed or dropped packets.[18]

Proponents of flat pricing argue that such a mechanism is more convenient for both consumers and providers in that it simplifies accounting issues, as well as encouraging usage. Furthermore, flat pricing provides a guaranteed revenue stream with which ISP's can recover the high sunk costs associated with developing the infrastructure of the network (Clark 1997, Anania and Solomon 1997).[19] Unfortunately, the conveniences that come with flat pricing also correspond to several elements that can cause inefficiencies. First, and most obvious, the flat price does not induce users to take into account the congestion costs (an externality) that they impose on other users during peak periods. Given that users are charged the same price to send data regardless of when the data is sent (essentially nothing, given that they have paid for access already), each user is faced with the classic prisoner's dilemma problem: individuals would be happier if others stayed off the network during periods of congestion, but each user would prefer to send their transmission and wait a bit, rather than get off the network altogether. As a result, as one would expect, users continue to log onto the network, even in periods of high congestion, causing degradation in service quality.[20]

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are treated equally (which is commonly the case under a flat-pricing regime).

[18] Werbach (1997) provides an excellent discussion of the numerous potential congestion points on the Internet, including backbone congestion, and switch congestion at various points on the Local Exchange Carrier (LEC) networks being employed for transmission.

[19] Because it is essentially costless to provide access to a user once the infrastructure is developed, charging the marginal cost of production of access (which is conventionally associated with the "efficient" competitive outcome) would lead to a price necessarily equal to zero. Unfortunately, such a scheme makes it impossible to ever recover the costs expended by developing the network.

[20] Odlyzko (1997) points to American Online's (AOL) 1996 experience with pricing mechanisms as evidence of this real world tragedy-of-the-commons. When AOL switched from usage-sensitive pricing to flat-pricing, users flooded the system, at times leaving their connections on unattended; leading to excessive delays and, at times, complete system breakdown.

Another problem, closely related to the first, is that the flat price does not discriminate between "high" and "low" value applications. As a result, a teenager sending a video stream of his summer vacation can plausibly take precedence over a video conference-call of a Fortune 500 company. Even if the Fortune 500 company would be willing to pay a premium for higher-quality service, most current flat-pricing packages do not provide such an option. The lack of discrimination, combined with the deterioration in quality of "high" priority applications that comes with increased traffic on the network has led to the examination of more usage-sensitive and priority-sensitive pricing mechanisms that could, in theory, lead to a more efficient allocation of resources than could be accomplished by the flat-pricing scheme.

2.2 Auction Approach

One pricing scheme that has been posed to avoid some of the inefficiencies inherent with the flat-pricing schedule has been discussed by MacKie-Mason and Varian (1993, 1995, 1997). The authors first note that most of the costs associated with backbone networks are the fixed costs incurred with creating the infrastructure. In times when the network is not saturated, the cost (i.e., delay time) of sending a message is zero and packets travel seamlessly from sender to receiver. In times of high congestion however, packets are delayed, leading to them being dropped from the queue, and re-sent from their origin. The authors propose a per-packet pricing mechanism that varies according to the congestion level on the network.

More specifically, the authors envision a mechanism that has the following characteristics: first, the incremental costs of sending a packet should be zero when the network is uncongested (to accurately reflect the social costs of the transaction at that time). Second, the social costs of delaying others' packets should be internalized by a given user and be positive. Third, funding for the infrastructure should be covered by some sort of fixed connection fee that should vary between consumers as a function of their relative willingness to pay. In trying to accomplish the above goals, the authors present a "smart market" in which each user pays a flat fee for connection to the network and then submits a "bid" with each packet for the amount that they are willing to pay to have that packet transmitted. The "bid" is submitted by attaching it to the header of the packet[21] and is only a bid for the relative priority of service, in the sense that higher bid packets enter the queue before lower bid packets, but it is impossible to guarantee priority in delivery due to network issues at the other end of the transaction.

Given this specification, the price paid at each router by a given bidder is the market clearing price; which is defined as the bid submitted by the first person whose packet is not sent due to the capacity constraints of the network and the range of bids submitted. Applying this mechanism to the Internet, for example, if a router could only forward 5 packets, and 10 packets were submitted for consideration with bids attached, then the first five highest-valued packets would be accepted and sent on, and the users whose packets were sent would pay the bid attached to the sixth-highest valued packet.[22] The authors argue that the use of an auction in this setting has several desirable efficiency properties. First, it should be evident that the smart market proposed by the authors succeeds in inducing customers to pay non-zero positive prices when the social costs of their packet transmissions are positive, while paying prices equal to zero when the network is uncongested. Second, the authors claim that this mechanism is analogous to a well-established mechanism known as the Vickrey auction, in which a bidder's dominant strategy is to bid their true valuation of the item being sold (in this case, packets).[23] Hence, the

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[21] The authors note that IP addresses currently contain fields for "priority" and/or "type of service" (TOS) specifications. Hence, using a subsection of the IP address as a bid field seems technologically feasible.

[22] It should be evident that the sixth-highest bid is the marginal bid, because anyone who submitted a bid less than the sixth highest would strictly prefer to keep their money rather than pay the sixth-highest price for service. Conversely, anyone who submitted a bid greater than the sixth highest bid would strictly prefer to pay the sixth highest bid over their own bid for packet transmission. Finally, the individual who submitted the sixth highest bid, if that was their true valuation for service, should be indifferent between paying for their service and keeping their money without transmission.

[23] In a Vickrey auction bidding one's valuation is a dominant strategy because the value of a user's bid only affects the price that user pays when he is the marginal bidder. In such a situation, if a user were to overbid his true valuation, the only time it would change the outcome would be cases in which he received service but paid a price higher than his valuation. Conversely, if a user underbid his true valuation, the only time it would change the outcome

authors claim, from an efficiency standpoint, their smart market ensures that bidders will not misrepresent their valuations, leading to their paying more, or less, than the true valuation of their transmissions.[24] Third, in further results, the authors show that the revenues generated from such a mechanism will equal the optimal level of investment in infrastructure capacity.

Despite these favorable qualities, the authors address several concerns pertaining to their proposed smart market. Among other issues, they concede that many individuals might not find the notion of fluctuating access prices attractive. To counter this criticism they note that first, fluctuation of the network prices will occur less often as prices and availability become more predictable through the use of the market. Second, the smart market should lead to only downward fluctuations in price with respect to a bidder's expectations.[25] Finally, institutions, such as intermediate sellers, can emerge in this market to sell to end users who are hesitant to enter the market directly. Another point addressed is the skepticism over whether or not a smart market can accommodate the inherent "burstiness" (i.e., quick fluctuations in traffic over short periods of time) that is present with many packet transfers. To ameliorate concerns over this issue, the authors argue that the technology currently exists to handle the complications that accompany such burstiness, as well as arguing that the implementation of the smart market should lead to an overall decline in the market burstiness.

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would be cases in which he was denied service despite having a higher actual value for the service than the posted price. Hence, a user can do no better than simply bidding his true valuation for the product in question.

[24] MacKie-Mason and Varian's claims about truth-telling being a dominant strategy in their smart market are somewhat questionable due to the fact that their auction is more representative of a uniform-price auction than a multi-unit Vickrey auction. Ausubel and Cramton (1998) discuss how a uniform price auction does not possess the efficiency properties, particularly with respect to truth-telling, of the multi-unit Vickrey auction.

[25] Because a bidder is only paying the marginal price of service, any large "fluctuations" in price should manifest themselves as large downward shifts from the expected price paid, if the marginal user has a far lower valuation for the service than a given bidder.

2.3 Static Priority Pricing

A simple model of access pricing, that differs from MacKie-Mason and Varian's smart market, is presented by Cocchi, et al. (1993).[26] The authors first note that the development of applications such as real-time audio or video streams place high demands on the network that render current pricing schemes (mostly flat-pricing at the time the paper was written) unable to efficiently manage congestion. Furthermore, they point out that users are likely to place different weights on the value of quick access to the network, depending upon what sort of application is being used. For example, it is reasonable to believe that most users would be willing to tolerate delay in email packet delivery, but less willing to tolerate delay in real-time audio or video transmission. Recognizing this difference in delay valuation, the authors propose to create different priority classes for the network (as a function of expected delay) and have the users self-select which priority class they would prefer for the packets they send. The authors do not propose actually partitioning the network into different priority classes, but rather assigning "priorities" to packets when they are sent, which represents where they will be placed in the queue should the network become congested (at which point, they will be handled according to FIFO).

It should be obvious that any sort of priority class system must attach some sort of pricing scheme to the different priority classes in order to induce efficient self-selection into the classes.[27] In the Cocchi, et al. model, users' utilities are defined over the value (negative) that they place on the delay time for a given packet and the amount of money that they pay for transmission. The sequence of events consists of users simply placing an order for service at a particular priority level, paying the fee associated with that priority level, and having their

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[26] Variants of this model are discussed in Braden, et al. (1994), Clark, et al. (1992), Shenker (1995), and Shenker, et al. (1993).

[27] Without monetary considerations, all users would have an incentive to specify the highest priority level for all of their applications, leading to the network being just as congested as if there were no priority classes.

packets sent. Using a very general framework, the authors derive results showing that prices can be constructed for different priority classes which maximize aggregate welfare for all users in the network. The prices for priority classes are not updated every period in response to the level of network traffic; rather, prior to making their service request, users are faced with an unchanging (i.e., static) menu of priority levels from which to choose. Considering different users who are selecting service levels for four different applications (email, ftp, telnet, video) the authors demonstrate, through simulations, how a static two-priority ("high" and "low") pricing system can generate the socially desirable congestion level for a wide array of network configurations and load usage.

While the static priority pricing system seems to have some very attractive implementation properties, especially from an accounting standpoint[28], there are certain issues that might concern a network designer. First, because the prices are unchanging with respect to network load, as a matter of efficiency, there may be cases in which users are paying inappropriate amounts for the level of service they request. For example, when the network is completely uncongested, high-priority users will effectively be overpaying to have service identical to low-priority users (essentially, no delay), and conversely, when there is excessive congestion, high-priority users may be underpaying, leading to further congestion. While it is true that these effects might "even out" in expectation, on a point-by-point basis, it seems that a more dynamic approach to network pricing may be more desirable. Concerns might also be raised (Gupta, et al. 1997a) over the feasibility of implementing such a system on a large network where a central planner might have limited information over users' priority preferences, that could serve to inhibit the derivation of efficient priority prices. Regardless of how valid this latter point is, Cocchi, et al. succeed in showing that implementing some sort of differential

[28] There is no need to worry about what path a given packet takes in trying to assess charges. Users are assessed a simple entry fee per application for a given priority level, and then the system does the best it can in providing service.

pricing scheme between priority levels, even in a static setting, can succeed in enhancing social welfare.[29]

2.4 Dynamic Priority Pricing

Addressing some of the concerns associated with Cocchi, et al.'s model, a more complicated model of priority pricing has been developed in a series of papers by Gupta, Stahl and Whinston (Gupta, Stahl and Whinston 1995, 1996, 1997b, 1997c). Similar to MacKie-Mason and Varian, the authors argue that flat-pricing methods are inappropriate for Internet communications, and some sort of congestion-pricing mechanism should be adopted to enhance efficiency of the network. While admitting that the auction presented by MacKie-Mason and Varian is attractive, Gupta, et al.(1997a) argue that the efficiency properties associated with the auction are contingent on two conditions being satisfied: all potential packets must be present at the auction, and the value of a packet is independent of the conditional passage of other packets. Both of these conditions, they claim, are obviously violated in the Internet environment where there will almost always be a time delay at congestion points between packet arrival and bids, and the value of packets are obviously affected by the drop rates in the network.

Rather than attempt to refine MacKie-Mason and Varian's proposal to account for these problems, Gupta, Stahl and Whinston begin anew by claiming that any sort of congestion pricing scheme should satisfy the following conditions. First, it should be constructed from some sort of theoretical basis (e.g., microeconomic theory). Next, it should be operational and adjust prices in real time. The overhead costs associated with implementing such a system should be manageable, and it should be adequately tested before being deployed onto a network. In trying to satisfy these conditions, the authors develop a priority-pricing mechanism that, in theory, could be implemented in a completely decentralized environment; and through simulation, can be shown to be more efficient than a flat pricing model for network access.

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[29] Citing the postal system's mailing policies, (e.g., overnight, priority mail, standard first class, etc.), Einhorn (1995) also speaks of the virtues of static-priority pricing schemes as a technologically feasible and welfare enhancing pricing mechanism.

Grounding their model in a general equilibrium framework that generically incorporates the preferences of all relevant users and service providers, the authors consider a scenario where users are faced with a variety of access options (varying in estimated delay times, price, and quality of service) and choose the expected optimal access option.[30] The result of such a process leads to the realization of a "stochastic equilibrium" that has the following properties: "(i) average flow rates of service are optimal for each user given the prices and anticipated delay, and (ii) the anticipated delays are correct ex-ante expected delays given the average flow rates"[31] (Gupta, et al. 1995). A third property of the stochastic equilibrium prices is that their adoption maximizes social welfare.

Delving into the specifics of the model, the dynamic that they propose operates in countable periods (discrete time), and in each period a user is presented with a menu of options listing the relative prices for different priority classes as a function of delay time or other qualities. After considering each option, a user (or perhaps an electronic agent which has been programed with the user's preferences) selects the option that he prefers (which might include not using any service at all, as would manifest itself in best-effort service). After selecting their option, a user's request is sent to the least cost available server where it is immediately processed if the queue is empty. In the event that the queue currently has jobs in it, users' requests are processed in a first-in-first-out (FIFO) method as a function of priority class. The estimates for prices in the user's initial menu are updated every T units of time, and the authors assume that the actual prices in period (t+1) are a function of the prices in period (t) and expected prices in period (t+1) (where prices are positively correlated with delay times in the previous period, which increases with the number of users on the system).[32]

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[30] Economists would refer to this choice as choosing to maximize one's "ex ante utility".

[31] This latter condition intuitively means that conditional on the average level of user traffic being known, users' expectations about plausible delay times will be realized.

[32] The authors offer three arguments for updating every T periods rather than in response to when service requests are made. First, estimating delays and prices over longer periods of time produces more stable results. Second, small perturbations in prices will not warrant

Having developed the model of priority-pricing, the authors simulate user service requests to compare aggregate welfare under systems of free access to the network, flat pricing, and priority pricing. In addition, the authors also consider how the system operates in the cases where there is perfect and imperfect information with respect to the delay times for a given job. In all cases, simulation reveals that a dynamic priority pricing system does better than both free access and flat pricing. While it is unsurprising that their model performs better in cases of perfect information with respect to delay times, even in cases where the prices are a function of expected delay, the priority-pricing model generates higher social welfare than the other two options because the imposition of prices for different service levels effectively constrains congestion. From these results, the authors conclude that, contingent on the availability of supporting technologies, their model is a practical and desirable alternative to current flat-pricing practices.[33]

2.5 PMP Approach

A proposal that has attracted less attention than preceding options but also involves users sorting themselves as a function of their respective budget constraints has been put forth by Odlyzko (1997, 1999a, 1999b). Dubbing his model the "Paris Metro Pricing" (PMP) approach, Odlyzko proposes to actually partition the network into different, independent routes, and assign different prices for access to each route. The model's name comes from a characterization of the

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frequent updates once a stochastic equilibrium is realized. And finally (and most compelling given that this model is meant to be practical), the computational effort associated with updating following each service request is likely to be prohibitively high.

[33] Similar to Cocchi, et al.'s proposal, an especially attractive feature of the stochastic equilibrium model is that it reduces accounting issues significantly. All entities in the transmission chain are only presented with one bill, which represents the cost of sending a packet to the next node in the network. Of course, in equilibrium, subsequent transmission costs between links are accounted for in the bill presented to the prior link. The one critique of their approach is that despite criticizing the theoretical underpinnings of MacKie-Mason and Varian's approach, they do not offer side-by-side simulation comparisons to determine which model might perform better under particular assumptions about user demands for timeliness, price, etc.

Paris train system where, until the 1980's, first and second class seats were completely identical in number and quality, with the exception of the price assigned to each (first class seats were priced higher). This difference in price led to a de facto difference in quality between the first and second class cars, given that more people would purchase second class tickets, increasing congestion on second class cars, while first class cars remained less occupied, and hence more comfortable.

Applying this intuition to the Internet, Odlyzko proposes a system where, unlike the static priority-pricing model proposed by Chocchi, et al., the different prices assigned to the routes will not reflect differences in precedence levels across routes, and not even different quality-of-service guarantees. Odlyzko posits that similar to the Paris Metro system, these differences in transmission costs will lead to expected differences in quality-of-service on the part of users. These expected differences in service quality will be realized as users sort themselves depending on willingness-to-pay, leading to lower congestion levels (i.e., better service) on the higher-priced channels. The attractive properties of the PMP system Odlyzko contends, are (1) after being developed, it is relatively inexpensive to administer, and (2) from a technical standpoint it should be easy to implement given that current Internet Protocol standards could be altered in such a way as to designate the portions of the network onto which a given packet should travel.[34]

While PMP seems simple in principle to deploy, Odlyzko sees two main practical problems with the system with respect to efficiency. First, for applications to run well, there must be sufficiently low traffic on the system, which raises questions as to how to theoretically partition the network to ensure that portions of it are not being under/over-utilized. Closely related to this issue is a second problem; from a technical standpoint, current technologies (as of 1999) make it extremely difficult to actually measure the traffic on the Internet, making development of efficient partitions difficult to conceive. These technical concerns aside, the

[34] As of 1997, when the theory was developed, IPv4 packets had a 3-bit priority field that was unused (Odlyzko 1997, p. 9). In theory, it would be simple to assign a network class to this priority field that would designate which portion of the network the packet would use for transmission.

PMP system seems attractive in the sense that while possibly unable to achieve "optimal" efficiency, it would likely alter the current Internet in such a manner as to ensure that "high" priority applications were not subjected to the current delays that they experience under a flat-pricing mechanism.

2.6 Summary and Implications

In considering the body of work being developed on the pricing of Internet access, one might wonder how relevant such research is to the future evolution of the Internet. In answering this question, one should consider the following points: between 1998 and 2003, the number of U.S. households that are connected to the Internet is expected to increase from 33 to almost 60 million (Carmel, et al. 1999).[35] At the same time, it is expected that there will be a proliferation of data intensive real-time applications such as Internet telephony and video conferencing. These two trends will likely lead to a substantial increase in both demands for access more generally, and demands for high-speed access, such as that provided by broadband technologies (e.g., DSL, cable modem), in particular. Combined with the increased traffic that will likely follow as currently underexposed populations in other continents such as Europe and Asia gain access, it is reasonable to assert that absent any sort of change, either through pricing policies or technological innovation, the quality of standard service that accompanies a flat pricing regime may deteriorate.

On the supply side, recent technological developments have emerged that might serve to ameliorate congestion, absent changes in pricing. Werbach (1997) discusses how the simple increase in backbone capacity can help to solve congestion-related problems.[36] Another

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[35] If one is focusing on the number of adults connected to the Internet at the end of the century, the estimates range from 72 million (Carmel, et al. 1999) to 110 million (http://www.c-i-a.com/199911iu.htm). Moving into the new millennium, one estimate has placed the number of web users in 2001 at 175 million (Thompson 2000).

[36] Questions exist over whether simple capacity expansion can effectively reduce congestion. Huberman (1997) has argued that capacity expansion would actually increase congestion because users, believing that expanded capacity should facilitate data-intensive

alternative is to implement "caching" technologies, which effectively reduces Internet traffic by aggregating and maintaining content (e.g, an electronic newspaper's webpage) in a location that is easily accessible to a pool of users, rather than requiring these users to individually seek the content at its original source (Thompson 1999, 2000).[37] Finally, Werbach (1997) and Mace (2000) argue that the adoption of various technological protocols by network designers can help facilitate differentiated levels of service, which, when combined with an appropriate pricing scheme, can help to alleviate congestion.

Moving beyond supply-side alternative, experiences in Berkeley, CA (Edell, et al. 1994) and New Zealand (Brownlee 1996) have shown that implementing various usage-sensitive pricing mechanisms can significantly alter consumers' Internet usage patterns. Winston and Shirley (1998), in studying a seemingly analogous problem of automobile traffic congestion, have also argued in favor of congestion pricing mechanisms as an efficient way to manage road (network) resources. While the options proposed in the previous section might serve to alleviate congestion under certain conditions, and may even provide an "efficient" allocation of Internet resources, there are technological and distributive concerns that follow from these options that make them less than ideal. From a technological standpoint, it is questionable whether adequate accounting mechanisms can be devised to make some of these options useful and feasible alternatives to a flat-pricing regime. When one considers the global implications of network interconnectivity, it is easy to envision the difficulties that might arise in trying to establish and coordinate an international accounting system that facilitates a particular pricing policy.

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applications and higher levels of service, will engage in higher/more intense levels of web-usage than they ever would in the absence of expansion. This increase in usage, he claims, would likely overcome the efficiency gains that might normally be made by any capacity expansion.

[37] Concerns have been raised over whether caching can cause other difficulties, in the sense that the content being stored on the local server can easily become out-of-date/obsolete between the time that it is originally downloaded and when it is finally viewed by a user. Proponents of caching argue that such problems will eventually be solved through technological innovations (Thompson 1999).

Furthermore, even if a given system can be technically implemented, the models proposed are only being compared against the conservative benchmark of a flat-pricing regime, and none are being tested against each other in order to see which might prove "most efficient". Hence, there is little evidence from which to argue that a particular mechanism might produce the best outcome. Future research might attempt to fill this void by testing these proposed models against each other, either through simulations or in experimental settings, to determine which mechanisms perform best under certain circumstances.[38]

Considering distributional issues, arguments can also be raised against any sort of usage-sensitive mechanism that discriminates according to consumers' willingness-to-pay. While such mechanisms may achieve an outcome that is appealing on efficiency grounds, more normative policy concerns (e.g., concerns over the "digital divide") may favor opening up the Internet to those who otherwise would not have access due to the costs imposed by providers.[39] Finding an appropriate middle ground between these conflicting goals is likely to be one of the most challenging issues pertaining to access provision in the coming years.

Anticipating that the availability of quality Internet access might become a scarce resource, the question turns to where might one expect to see potential problems for competition. Any projections of this sort are uncertain at this stage, in the sense that any claims made might be proven technically trivial or generally unfounded within months of this writing. That being said, it would be worthwhile to note particular phenomena that might appear to raise concerns. As attention is turned to the development of broadband access, it is important to consider the

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[38] In addition, given that ISPs and backbones are private enterprises, it seems reasonable that a congestion pricing mechanism could only be implemented if there were sufficient demand for it on the part of consumers. Contrary to theoretical arguments in favor of congestion pricing, empirical findings by Calfee and Winston (1998), demonstrating that even the wealthiest automobile commuters are hesitant to pay for lower travel times, beg the question as to whether "sufficient" demand for a congestion-sensitive pricing system will ever be realized.

[39] An alternative, less distorting, option might be to give income supplements to those that were disadvantaged, and let them decide how/if to purchase access as a function of pricing and services offered.

possibilities of market power on the part of both the backbone providers and providers of broadband services. While the issue of backbone access will be discussed further in Section 4, the issue of broadband provision will be discussed here. The introduction of broadband technologies will provide service that is far superior to that of conventionally used "narrowband" technologies, such as standard (i.e., non-DSL) copper telephone wire. Realizing that they might be locked out of the broadband market, ISP's began lobbying government officials in 1999, arguing for mandated access.[40] ISP's claimed that such measures were necessary to ensure that Internet access monopolization by broadband providers could not occur. Conversely, cable providers pointed to the huge capital investments that they had made in their networks (as much as $100 billion), and argued that they had the right to earn a substantial rate of return on their investments (Warren and White 1999).

This recent debate has raised new questions as to whether competition in access provision would be better served by letting industry hammer out the access issues themselves (Kopel 1999), or by government intervention (Einhorn 1995, Sarkar 1997). Sarkar (1997) in particular, has argued for government regulation of access, claiming that the implementation of any sort of dynamic pricing model must be overseen by some sort of regulatory body to ensure that manipulation and other anticompetitive practices are not possible.[41] On the issue of broadband provision, MacKie-Mason (1999) has demonstrated that under a variety of assumptions about market structure, mandating access to broadband facilities could enhance both consumer and broadband-provider welfare. These issues will be discussed in greater detail in Section 4 of this essay.

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[40] AOL and other ISPs, for example, formed a lobbying group named *openNET*, which pressed government regulators to compel broadband providers such as AT&T and Time-Warner to sell them access to their networks (Warren and White 1999).

[41] Sarkar identifies the smart market proposed by MacKie-Mason and Varian, in particular, as a mechanism that is ripe with potential for abuse. In theory, those who control the system bottlenecks might be able to artificially inflate the level of network congestion in order to raise revenue. Furthermore, Sarkar argues that a smart market would require a high degree of coordination in order to function, which could not be achieved absent government intervention.

Section 3: Pricing of Goods and Services on the Internet

One of the topics that has received the most attention in the popular media is how the Internet is affecting traditional markets. Specifically, changes in search costs, ease of information acquisition, and reductions in the need for conventional shelf space in the "e-marketplace" have led scholars and journalists to speculate how the Internet will contribute to such disparate effects as the proliferation of personalized products and the death of the bricks-and-mortar retail outlet. Bakos (1998) claims that the three main purposes of a market are a) to match buyers and sellers, b) to facilitate the exchange of information, goods and services, and payments, and c) to provide some sort of institutional infrastructure. Having established these principles as "functions of the market", he then argues that the rise of the electronic marketplace will fundamentally change all of these functions. Similarly, a 1998 article in *Business Week* (Kuttner 1998) claimed that the Internet is a "nearly perfect market" and the costs and availability of information will lead to "fierce price competition, dwindling product differentiation, and vanishing brand loyalty."

With these issues in mind, this section will address the current literature that deals with the pricing and production of goods and services that are sold over the Internet. Among the issues that will be addressed are: How can changes in consumer search costs affect pricing policies of online merchants? By what methods can information goods be packaged and sold in this new environment? How does information acquisition on the part of firms affect prices offered to consumers? In many cases, it will be seen that the answers to these questions follow from conventional microeconomic theory, but unlike conventional retail outlets, the Internet provides a scholar with a unique environment in which assumptions that were previously considered unrealistic (e.g., perfect information at negligible costs), are no longer so implausible.

3.1 Effects of Search Costs on Pricing Policies

Many conventional economic models implicitly assume that search costs on the part of the consumer are either negligible or altogether nonexistent. In a market of undifferentiated goods, conditional on negligible search costs and the usual technical assumptions being satisfied, the traditional Bertrand model of price competition would predict that goods will be priced at the marginal cost of production, and all firms will earn zero profits. While such a result is obviously desirable to consumers, the failing of the traditional assumptions might lead to something other than the predicted Bertrand competition equilibrium price. In considering the presence of positive search costs, several studies have derived theoretical results predicting above-marginal-cost pricing.

One of the seminal works in this field is Diamond (1971) who considers a model of price determination with positive search costs. Diamond's model of a market consists of several identical firms and consumers who operate in discrete time. In each period a firm sets a price for their good and a consumer enters only one firm Upon entering, a consumer either makes a purchase, or decides that the good is priced too high and visits another firm in the subsequent period. In every period, a consumer updates his "cutoff" price, (i.e., the price such that they purchase a good in a given period rather than continue to search), as a function of his underlying demand and expectations about finding a better deal. While the specific dynamic is not analyzed, Diamond assumes that consumers raise their cutoff prices between each period to correspond with a positive search cost they accrue between periods. The main insight of this model is that because of positive consumer search costs, firms will set an identical price that maximizes joint profits, and is greater than the competitive equilibrium. Conditional on certain assumptions being satisfied, this price will be the monopoly price.

Using Diamond's work as a starting point, several other studies have investigated the theoretical effects of search costs on pricing dynamics. Robert and Stahl (1993) consider pricing practices by firms who are able to effectively lower/eliminate search costs through the provision of informative advertising. Envisioning a market of a finite number of firms selling a homogenous good and consumers who are initially uninformed about prices, but can learn prices through either searching or advertisements, the authors investigate what kinds of advertising and pricing decisions firms will make, depending on consumer demands, search costs, and market structure. Conditional on certain assumptions holding, a unique equilibrium exists in which firms either charge a high price and do not advertise, or two prices, high and low, where they advertise the low price aggressively.[42] The presence of advertising will produce heterogenously informed consumers, and the authors find that as adverting costs decrease, the equilibrium price converges to the marginal costs of production (i.e., the traditional Bertrand equilibrium).

Placing their findings in the context of the Internet, one might predict that prices posted on the Web tend to be lower than in the physical world because advertising costs, per capita, are far lower. While this prediction seems sensible, Robert and Stahl provide another result that might conflict with this assertion: holding advertising costs constant, as search costs decrease (as one would suspect they do on the Internet), prices may still remain above marginal costs. Such a phenomenon occurs because these lower search costs reduce the incentive to advertise; and in doing so, place the burden of information transmission on the consumer. Hence, with (even slightly) positive search costs, Robert and Stahl's model is similar to Diamond's in that merchants will try to raise prices as much as possible to maximize profits. Unlike Diamond's model, however, the ability of any one merchant to raise prices is constrained by the ability of other firms to advertise (if some firms raise their prices too much, than other firms might find it profitable to advertise, drawing all consumers to them). Given that it is likely that a) merchants on the Internet face differential advertising costs, and b) consumer search costs are non-zero, the implications of Robert and Stahl's model for prices on the Internet are ambiguous.

A more recent paper by Stahl (1996) ignores advertising concerns and focuses solely on price determination in a world where consumers have varying search costs associated with shopping.[43] In Stahl's model, a finite number of stores sell identical goods; and similar to Diamond, consumers must visit a particular store to learn a price. Also similar to Diamond, Stahl's shoppers have a reservation price that determines whether they stop their search process

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[42] The equilibrium concept adopted by Robert and Stahl is Perfect Bayesian.

[43] The motivation for the differences in shoppers' search costs stems from consumer differences in the disutility associated with shopping. In other words, those who like to shop are likely to have lower costs associated with search than those who hate to shop.

and purchase, or continue to shop. Stahl shows that any price between marginal cost pricing to monopoly pricing can be supported in equilibrium, depending upon the underlying distribution of consumer search costs. In the event that no consumers enjoy shopping, the equilibrium (subgame perfect) is monopoly pricing by all firms, whereas as more shoppers' search costs converge to zero[44], the equilibrium price converges to marginal cost pricing. For any distribution in between these two extremes, however, no pure strategy equilibrium exists, and a wide range of pricing schemes might be observed.[45]

While these three papers are only a small sample of the work that has been done in this area, their findings are representative of some of the conclusions that have been drawn pertaining to the relationship between consumer search costs and firm pricing practices.[46] Generally speaking, one should expect that as consumer search costs are driven down, firms will respond by lowering their prices closer to marginal costs, but many factors might constrain complete convergence. Hence, in the environment of the Internet, where search costs are relatively trivial compared to shopping in bricks-and-mortar outlets (mouse clicks versus car trips)[47], one should

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[44] More specifically, as the density of shoppers converges to a spike around zero search costs, marginal cost pricing is realized.

[45] In considering how market structure might influence price, Stahl's model also shows that under certain conditions (the density of shoppers being finite), the number of stores has no bearing on whether or not prices converge to marginal costs. Hence, even with a substantial expansion of stores, as is being observed on the Intenet, prices might not converge to the competitive equilibrium.

[46] Other industrial organization papers that study the relationship between search costs and price dispersion are Axell (1977), Rob (1985), Salop (1977), Salop and Stiglitz (1982) and Stiglitz (1987).

[47] At the same time, the extent to which this generalization holds true might depend on a given consumer's knowledge about the products being considered. For example, consider the book market. If a shopper knows the title and/or author of a book, search costs on the Internet are trivial. Conversely, if the consumer only knows the book's subject, and/or what its cover looks like, searching for the title on the Internet might prove difficult. Further technological innovation may eventually solve problems such as this, but at the moment, it is difficult to conclude that Internet necessarily facilitates low search costs.

expect that electronic merchants should be lowering their prices accordingly. In response to this conjecture, a sizable body of work has recently been developed that aims at both theoretically and empirically investigating the relationship between reduced transactions costs and pricing in the electronic marketplace.

Bakos (1997), in focusing primarily on the effects of reduced search costs on electronic marketplaces, begins his inquiry by postulating that extreme reductions in search costs might lead to the destabilization of oligopolistic pricing, which in turn that can lead to price wars, that will eliminate excess profits in a given market. Building on Salop's (1979) spatial competition model of differentiated products, Bakos considers a world in which sellers choose where to locate on the unit circle, and consumers learn the prices and locations of given sellers for a constant cost, c. Upon learning the location and product offerings for a given merchant, a consumer decides whether to purchase from a given seller, or to incur search costs to look for a seller whose products/prices are more to their tastes.[48] Among the conclusions derived by Bakos are first, with a large number of firms and no search costs, the equilibrium is characterized by seller profits equal to zero. Conversely, in the presence of high search costs, significant allocational inefficiencies exist; and in cases of extremely high search costs, complete market failure can ensue. Given that extremely high search costs can lead to complete market breakdown, Bakos claims that "electronic marketplaces will enable 'missing' markets, thereby creating substantial social surplus."[49]

Besides showing how electronic marketplaces might yield benefits to buyers/consumers, Bakos also investigates the corresponding incentives of sellers to invest in the development of

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[48] The equilibrium concept adopted by Bakos is Perfect Bayesian.

[49] Bakos uses unemployment as an example in which a market (i.e., the labor market) has broken down due to the excessively high search costs associated with matching workers and employers. By lowering the search costs associated with this process, perhaps by creating a job clearinghouse on the Internet (e.g., Monster.com), unemployment can be significantly reduced, enhancing social welfare. No research has been conducted, as of yet, that examines the effects of the introduction of such clearinghouses on unemployment rates.

such marketplaces. As would be expected, sellers are apt to be opposed to the introduction of systems that lower buyers' search costs because such systems, in turn, would lower sellers' profits. Given that it is difficult to prevent the introduction of any sort of marketplace, however, Bakos suggests that sellers have three options that might aid them in their efforts to preserve profits. First, they might seek to take the initiative and try to influence the kind of system that is introduced--perhaps by requiring user fees for access to the market that would serve to compensate for lost profits. Second, citing the airline industry, Bakos notes that sellers might want to compensate for the low cost of price information by raising the costs associated with acquiring product information.[50] Third, sellers might seek to increase the differentiation between their products, such that they are no longer competing with other firms over the price of identical products.[51] Regardless of what approach firms take, Bakos argues that the development of such markets is inevitable, and their introduction will enhance economic efficiency of conventional transactions.

Addressing the issue from an empirical angle, Bailey (1998a) examines price differences between online merchants and bricks-and-mortar stores for items such as books, compact discs, and software.[52] Noting predictions that emphasize the prospect for perfect competition on the Internet due to "frictionless" commerce following from lower transaction costs, Bailey seeks to establish whether Internet retailers differ from offline outlets in three specific ways with respect to pricing policies. First, an environment that encourages perfect competition (e.g., the Internet) should lead to products being sold at prices lower than their offline (presumably, less

[50] A reader need only consult the typical airline's website to confirm Bakos' assertion that electronic marketplaces have not necessarily facilitated the easy diffusion of information with respect to airline tickets.

[51] This latter possibility is very similar to results presented by Eaton and Grossman (1986) who show that when firms are able to first choose the level of differentiation before presenting product information, the unique equilibrium will involve firms choosing the maximum level of differentiation possible and full revelation of product information. By developing products that are completely different from each other, firms avoid a vicious price competition that would eventually end in competitive pricing and zero profits for all firms.

[52] This work is building on previous research in the author's dissertation, Bailey (1998b).

competitive) counterparts. Second, Bailey argues that another symptom of heightened competition would be less price variance in online versus offline prices, given that online merchants should be driven to pricing close to an identical (presumably, perfectly competitive) price. Finally, one would expect that heightened competition, combined with lower menu costs should lead to prices being changed more often on the Internet than in bricks-and-mortar world, as online firms are easily able to tweak their prices in response to other firms' adjustments.

Using data consisting of 24,000 price observations collected in February and March 1997 from 52 different retailers, Bailey tests whether the prices of Internet and offline merchants for identical products differ with respect to absolute level, dispersion, and frequency of change. While one might suspect that the above hypotheses find support in the data, Bailey shows that with the exception of the third hypothesis pertaining to frequency of menu adjustment, none hold true across all three markets of books, compact discs, and software. Surprisingly, the data show that across all markets, Internet retailers price significantly higher than physical retailers, and in two of the three markets (books and compact discs), the Internet retailers exhibit a higher level of price variance.[53] From these results, Bailey claims that the Internet does not currently approximate a world of "frictionless" commerce, and may not anytime in the near future. Furthermore, Bailey claims that the segmentation of the market into those who do, and do not, shop online will likely lead to some form of price discrimination for a variety of products that were, up until recently, priced uniformly. From a policy standpoint, Bailey emphasizes the need for strong consumer protection activities to ensure that buyers are not being exploited.[54]

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[53] Bailey attributes the lower price variance in software prices to the fact that when the data were collected (1997), search engines for software that could find the lowest price very easily were reasonably widespread, and more generally, that software tends to attract a "technically sophisticated and more demanding" consumer base.

[54] From an efficiency perspective, it is questionable whether the sort of price discrimination that Bailey is referring to is necessarily welfare-reducing and would warrant government intervention.

While Bailey's study is a solid first step towards uncovering whether the Internet might lead to the realization of perfect competition, his findings are weakened by possible flaws in his data collection method. In trying to collect data from offline retailers to compare with Internet seller prices, Bailey did not actually visit offline outlets, but rather collected most of his data from the bricks-and-mortar business' websites. The problem with such data collection, as he admits, is that there is no way to confirm that the prices posted on the Internet are identical to the prices of goods in the offline outlet. In the event that prices on these websites were systematically lower than those in their bricks-and-mortar counterparts, false inferences can easily be drawn. Specifically, one might conclude that Internet prices were not lower than offline prices, even if bricks-and-mortar prices were, in fact, substantially higher (but were different than those posted on their websites). A similar argument can be made with respect to the findings dealing with price dispersion.

A study that addresses the hypotheses posed by Bailey, but provides a less objectionable approach to data collection is presented by Brynjolfsson and Smith (1999). Focusing only on the markets for books and compact discs, Brynjolfsson and Smith collect pricing data for twenty books and twenty compact disc titles from eight Internet and conventional retailers. The offline retailers were selected at random from across the country, and attempts were made to ensure that the stores selected were not subject to any sort of systematic bias. Prices from the conventional retailers were acquired by either visiting the bricks-and-mortar outlet, or visiting its corresponding webpage after confirming that the prices posted on the webpage were identical to the offline outlet. A total of 8,500 price observations were collected between February 1998 and May 1999, and the main findings of Brynjolfsson and Smith's paper differ from Bailey's results in several ways.

First, Brynjolfsson and Smith find that prices on the Internet are significantly lower (between 9-16% less) than prices for identical goods in conventional outlets. Even when accounting for shipping charges and other costs associated with purchasing either online or in stores (such as sales taxes), there is still a cost differential favoring Internet purchases. Second, depending on the measure used for price dispersion, it can be shown that the variance in prices is lower on the Internet than in conventional markets.[55] Finally, and consistent with Bailey's study, Brynjolfsson and Smith find that Internet stores are far more sensitive to pricing changes than conventional stores in that Internet sellers exhibit far less "price-stickiness", changing their advertised prices by significantly smaller margins than offline outlets. From these results, the authors conclude that the Internet does, in fact, help to create a world of "frictionless" commerce, and that as more consumers find their way online, conventional retailers will find it increasingly difficult to compete with online counterparts offering identical products.

3.2 Packaging and Pricing of Information Goods

As noted by several scholars (Bakos and Brynjolfsson 1999a, 1999b, Odlyzko 1996, Shapiro and Varian 1999), the infrastructure of the Internet greatly reduces the costs associated with both reproducing and distributing information goods. Current technologies make it possible to reproduce copies of manuscripts, audio, or video recordings, that are identical in quality to the original document and distribute them to prospective consumers instantaneously over the Internet. Extremely large databases, which may have taken years to compile, can now be distributed to virtually anyone in seconds, ready for use upon arrival. The ease of replication, along with the ease of altering information goods in such a manner as to "customize" them to consumer tastes has raised several interesting questions about how these products can practically be packaged and priced for consumption.

In considering the selling of access to information goods on the Internet, such as a databases or electronic newspapers, one sees that such a transaction is very similar to a classic durable goods monopoly problem (Bulow 1982). A seller of a given information good is able to make copies of his product that are identical in quality to the original, and the use of these copies

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[55] The authors also discuss possible theoretical reasons for observed price dispersion. Noting that the most well-known and popular online firms tend to sell their products at some of the highest prices (e.g., Amazon.com), the authors claim that even on the Internet, when dealing with homogenous goods, reputation carries significant weight which might allow firms to charge above average prices.

(or the original) does not cause a decrease in the level of the quality of the good, opening up the possibility of a viable secondary market. An electronic copy of the New York Times is not going to depreciate in quality, regardless of how many times it is read (although it may decrease in value to a given consumer). In studying such transactions, the problem that faces producers is the classic "Coase conjecture" (Coase 1972)--unless they are able to commit to a specific (finite) level of production, despite their monopoly, they will be unable, in equilibrium, to price their good at anything above the marginal cost of production.[56]

While recent literature has not focused primarily on the implications of the Coase conjecture, several theoretical studies have emerged that analyze optimal pricing policies for producers of information goods given the unique environment of the Internet (e.g., the marginal costs of producing information goods is close to zero). Odlyzko (1996) has hypothesized that despite declining transactions costs associated with production and sales, retailers will still be able to devise various mechanisms in order to extract consumer surplus. Chief among these mechanisms are different bundling schemes and various differential pricing strategies.

Bakos and Brynjolfsson (1999a, 1999b, 1999c) present several studies investigating how sellers might choose to package multiple information goods into one product bundle. The authors show (1999c) that under some very general conditions, bundling of multiple goods can have some very desirable efficiency properties. More specifically, conditional on the marginal cost of copying a good being zero, and certain technical assumptions about consumers' demands

[56] Coase's result follows from the fact that producers are facing a known market demand function, time between transactions is negligible, and consumers realize that upon selling a given unit of a good, the monopolist will produce an identical copy and sell it, trying to extract additional consumer surplus. Hence, "high" value consumers who would be willing to buy the good for a high price, will choose to wait until the price drops after the first transaction rather than buy the first unit at a high price. Because no one will purchase the good for the "high" price, the monopolist will have to lower the price to the value of the next-consumer, but then because all consumers feel this way, it will be impossible for the monopolist to sell the product for any price above the marginal cost of production. Consumers, placing relatively high, as well as low, values on the good are willing to wait until the price is driven to marginal cost (which it ultimately will be) rather than buy it for a price above marginal cost.

holding, [57] then selling a bundle will be "remarkably superior" with respect to both producer profits and general welfare considerations than selling the bundled goods individually. Such a result follows from the fact that the inclusion of more goods into a bundle effectively makes the collective bundle attractive to a wider audience, leading to more consumers purchasing it, allowing the producer to collect higher profits than if he were selling each good individually. The authors note that their results hinge on both a negligible cost of reproduction and the fact that goods that provide negative utility will not be included in the bundle; each of which seem easily satisfied when using the Internet as a sales channel.

From these results, the authors conclude that a multi-good monopolist will obviously tend to do better in terms of profits by bundling their goods rather than selling them individually; and in considering implications for market structure, they argue that single-good firms can benefit from selling their goods to a coordinating firm that will incorporate the good into their multi-product bundle. Such findings provide a theoretical justification for why one might observe software providers acquiring smaller specialized software programs from potential competitors and incorporating them into omnibus software packages rather than letting them fend for themselves on the open market.

Considering other aspects of market structure, Bakos and Brynjolffson (1999b) consider a model where firms compete with each other over both acquiring content for their bundle and selling it as a package to consumers. The authors first consider a two period game where in the first period, two firms submit bids for content, and in the second period, a good is acquired by one or both firms, depending on whether the bids were for exclusive or nonexclusive rights to the content. Their central result is that, in equilibrium, the firm that has the greater initial level of wealth will outbid the less wealthy firm for exclusive rights to the good. Hence, the wealthier bundler will always be willing to spend more money to acquire monopoly rights over new products for their bundle. In the case where goods are being bid on sequentially, the implication

[57] Specifically, Bakos and Brynjolfsson assume that consumer valuations for goods are bounded and well-behaved, and that consumers exhibit free disposal.

is that the larger (wealthier) bundler will keep growing and adding more goods to its bundle as the weaker firm fails to acquire any new content.

Considering the downstream market for content, the authors present a two period game where in the first period, firms invest fixed costs into production (good acquisition), and in the second period, they decide whether to offer their content as a bundle or separate products. Results are derived that demonstrate the feasible ranges of costs wherein both firms will offer competing goods, and where such competition will be impossible. Conditional on certain assumptions being satisfied, the unique equilibrium will involve the firm with larger resources offering as many goods as possible in their bundle, and all consumers purchasing it over either the smaller bundle, or individual products. Furthermore, it can be shown that a bundler can always add profits to their bundle by adding goods, even if such goods are substitutes to existing content.

Because the marginal costs of adding more goods to the bundle are essentially zero when dealing with information goods, the authors argue that a potential entrant will be deterred from coming into the market for a broader range of costs than what would typically follow from normal competition. Simply put, a potential entrant will either be easily outbid in the competition for content, or else they will lose in the downstream competition for consumers; hence, such entrants will choose to stay out the market altogether. The authors note that such entry deterrence is not the result of any threat or dynamic strategy on the part of the bundler, but simply a function of the economies of aggregation associated with the bundle.[58] Given that bundlers will "always win" when facing either an entrant or an incumbent, Bakos and Brynjolffson argue that incentives for innovation are significantly reduced in markets where bundling is possible. If one believes that innovation is positively related to social welfare, then these results seem to contradict their earlier findings (1999c) about the positive welfare aspects of bundling.

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[58] The authors note that their results imply that a bundler could plausibly enter an incumbent's market where their bundle includes the incumbent's good and force the incumbent out, because all consumers will choose to purchase the bundle over the incumbent's good.

Having discussed the characteristics of bundling, the question then turns to how, precisely, might these bundles be offered to consumers? More specifically, speculations about the potential of network-based applications have raised questions about the economic viability of pricing policies for information goods. Network-based applications will allow users to download from a remote server via the Internet only those programs that they require at a given point in time, rather than having to buy a software package that will remain dormant on their hard drive when it is not in use. In such a world where information goods are, in effect, being rented like video tapes in a store, one might wonder if the rise of network-based applications might increase or decrease retailers profits. In addressing the virtues of buying versus renting information goods, Varian (1999a) considers cases in which a producer is choosing to price his product for purchase, rental, or both, as a function of consumer valuations and various transaction costs. Conditional on the transaction costs of sharing the product being lower than the marginal costs of reproduction, Varian concludes that creating some sort of rental market can increase producer profits (and enhance social welfare by opening up the market to those who otherwise would not experience the good). Varian cites the institution of site licenses as an obvious market where this principle holds--it is likely far more costly to provide support for an additional piece of software than the transaction costs of sharing it between users on the same networks. The same principle seems to hold for the prospect of network-based applications.

Addressing similar questions to those of Varian, Fishburn, et al. (1997) present a model of two-firm price competition for information goods when one firm sells their product for a fixed fee/subscription rate, while the other firm charges a per-use price. Disregarding earlier questions about the effects of lowered transactions costs on pricing policies, the authors focus solely on how differences in pricing schemes might affect competitive equilibria. The authors first show that in the absence of competition, a monopolist might actually rather sell information goods through either fixed price or subscription channels, rather than per-use/rental agreements. The value of selling a product for a fixed price over a per-use fee will depend on the distribution of consumers' demands and the costs of product distribution; and the authors claim that the "population distributions for which a flat fee is most profitable are more natural" than other possible population distributions. Such findings call into question the validity of conjectures about the future proliferation of per-use micropayment schemes for information good consumption. The authors also show that in the presence of competition between two firms, despite the difference in their pricing schemes, it will be difficult to avoid a price war that drives their prices down to marginal costs. Such a price war can only be avoided at the expense of one of the two firms, or in the presence of some sort of collusive arrangement.[59]

3.3 Prospects for Price Discrimination

While much work on bundling has centered around recent technological applications, there has been a sizable body of more traditional economic research aimed at uncovering the relationship between product information, consumer tastes, and pricing by retailers. Some of this research has aimed at discussing the strategic quality of information provision by sellers as a tool for market segmentation and price discrimination. Lewis and Sappington (1994) for example, consider a model where sellers decide how much product information to provide as a function of consumers' demands, and prior expectations about product characteristics and quality. The authors find that in equilibrium, firms will choose to a) either provide no information about their product and sell it for the average expected price, or b) provide extensive information and sell only to those "high demand" customers. The provision of product information in this game essentially leads to market segmentation between high and low valuation consumers, such that the sellers can post a high price that high demand consumers will find attractive given their knowledge about the products in question.

Moving beyond retailer's incentives to provide product information, a topic that has garnered significant attention in the popular press is how information acquisition by firms about their consumer base affects their pricing policies. Philips (1983, p. 14), in his seminal work on price discrimination argues that for price discrimination to occur, "markets must be separated."

[59] As a technical note, the authors demonstrate that competition can lead to above marginal-cost pricing for particular functional forms of the distributions of consumers' demands. These issues are covered rigorously in Fishburn and Odlyzko (1999).

This sentiment is echoed by Varian (1989, p. 599) who notes that a necessary condition for price discrimination to occur is the ability of firms to "sort" customers.   For several years, firms have been able to acquire detailed demographic information about potential (and actual) consumers from marketing research organizations, but for the first time in history, it is technologically possible to learn details about the particular tastes of consumers without them being aware of it, and independent of their purchase decisions. For example, by employing "cookies", a firm may be able to monitor a surfer's clickstream patterns through its website, and actually determine such factors as what products he was looking at, how long he was studying them, whether he compared prices with other items, etc.[60] Such information can be extremely valuable in that, combined with demographic information, a firm might be able to impute a user's demand function for their product and customize the prices for their products accordingly to maximize revenue.

Bailey (1998c) discusses these issues by investigating different ways that firms attempt to acquire consumer information and implement some form of price discrimination. Noting the conventional arguments about how price discrimination can significantly increase producer surplus, Bailey argues that price discrimination is likely to occur in markets where products and services have high asset specificity. For example, it is reasonable to expect that "news clipping services, collaborative filtering, and other customized Internet markets" will foster the flexibility in prices that would make price discrimination possible. This is not to say that homogenous goods are free from potential cases of discrimination. As an interesting illustration, Bailey points to the case of Books.com, an Internet-based bookstore that until recently, engaged in a form of

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[60] "Cookies" are small programs that are placed on a user's hard drive when they visit a given site. The cookie might keep track of the user's password for a particular site, where he surfs, what he purchases, etc. Upon returning to the site, the data stored in the cookie will be available to the website, and often the website will be customized in some way, in response to the cookie (e.g., password prompt will be waived). See Galla (1998, pp. 280-283) for more information.

third-degree price discrimination (i.e., providing different unit prices to different consumer groups).[61]

If a consumer were to visit Books.com's website he could conduct a typical search for a title/author/subject of their choosing. Upon finding the title he was interested in, he would be presented with the Books.com price, and then see a hyperlink for "Price Compare". Upon clicking on this hyperlink, Books.com would present the shopper with the prices for the title at Amazon.com, Barnes and Noble.com and Borders.com. In the event that the Books.com price was lower than these three, it would remain the official price; in the case where the Books.com was not the lowest however, the website would update their price to undercut the cheapest of the three, establishing the "new" Books.com price.[62] It should be noted that this "new" Books.com price would not be shown to a consumer if they had not choosen to price compare--so, Books.com was price discriminating in favor of those consumers who were more patient/price conscious, as exhibited by their surfing patterns.[63]

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[61] Books.com ceased to exist on November 3, 1999 when it was acquired by BarnesandNoble.com.

[62] For example, on October 1, 1999, this author looked up a title on social choice theory: "Positive Political Theory I: Collective Preferences and Political Analysis" by David Austen-Smith and Jeffrey Banks. The initial Books.com price was $39.45. After clicking on the "Price Compare" hyperlink, Books.com showed that the prices of Amazon.com, Barnesandnoble.com and Borders.com to be $39.50, $39.50, and $27.50 respectively. The "new" Books.com price was $27.20--thirty cents less expensive than the closest competitor, and 31% off of the publisher's list price ($39.50).

[63] This example is discussed further in a recent literature review on digital markets by Smith, Bailey and Brynjolfsson (1999). In illustrating how Books.com is effectively discriminating between consumers as a function of extreme price sensitivity and patience, the authors note that in a sample of twenty books, the average cost savings from clicking on "price compare" was fifteen cents. (Although they subsequently note (fn 10) "that academics seem prone to push this button independent of price-sensitivity considerations"). Following the acquisition of Books.com, Barnesandnoble.com encouraged former Books.com customers to shop at Barnesandnoble.com by offering a one-time redeemable ten-dollar coupon for a purchase larger than $25.00 at Barnesandnoble.com. Barnes and Noble did not adopt the price comparing features that made Books.com a competitive threat.

Noting that price discrimination is a plausible practice for most firms on the Internet, Bailey discusses mechanisms to avoid price discrimination. First among these mechanisms is price competition, which should (in theory) either reduce, or eradicate altogether, attempts at discriminating between consumers. Another possibility is for consumers to take control of their information by prohibiting its collection or dissemination without appropriate compensation. Bailey also claims that firm reputation, generally speaking, might inhibit price discrimination. Finally, electronic market intermediaries, such as "shopbots" that can automatically search the web for low prices, might render price discrimination ineffective.

Studying price discrimination from a different approach, and considering the issue in the context of lowered search costs, Kephart and Greenwald (1998) investigate the effects of the presence of shopbots on the electronic marketplace. As noted above, shopbots are electronic intermediaries that can search the web for the different products as a function of price or product qualities. Certain shopbots, such as the one used in the Books.com example, might only search for the prices of a limited number of firms, whereas the technology may be employed to learn the posted prices on hundreds of websites simultaneously.[64] Scholars and commentators (Casey 1999, Hagel and Singer 1999, Tapscott 1996, 1998) have argued that the widespread use of these programs will significantly enhance competition as retailers will be forced to constantly lower their prices to ensure that a particular shopbot recognizes them as the lowest price on the market for their relevant user. Considering a model where a portion of the consumers do not discriminate between sellers as a function of price, and another portion of consumers are "bargain hunters" who might employ shopbots to find the lowest price possible, Kephart and Greenwald analyze equilibrium pricing policies of firms.[65]

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[64] For a brief discussion of Internet agents, see Galla (1998), pp. 204-207.

[65] The model developed by Kephart and Greenwald is similar in motivation to earlier models of consumer search such as Salop and Stiglitz (1977) and Varian (1980). In both of these models, certain consumers utilize search tools, such as a newspaper, to learn market prices while others do not. Equilibrium conditions derived in these studies are substantively similar to Kephart and Greenwald's.

Contrary to popular speculation, the authors find that conditional on certain assumptions being satisfied, in equilibrium, only one firm will post their prices below the monopolistic price. Realizing that this result is contingent on certain informational assumptions being satisfied, the authors investigate its robustness by simulating an economy consisting of 1000 buyers and five sellers, where the sellers employ various adaptive learning mechanisms to determine their optimal prices.[66] While the adaptive simulation results are not identical to the theoretical results for all learning algorithms, the results are consistent, in that stable marginal-cost pricing by all firms is never achieved so long as a fraction of the consumers do not employ shopbots. Furthermore, for certain cases, simulations lead one to believe that the presence of shopbots could lead to phenomena such as cyclical price wars and widespread monopoly pricing. Finally, the authors note a seemingly perverse implication of their findings: the presence of shopbots might lead to retailers engaging in a veritable "arms race" over who can lower their prices faster. Such prices can only be lowered in response to the speed with which firms can acquire pricing information about their competitors through the use of shopbots, and the widespread and constant use of such shopbots can only serve to congest the Internet in a way that inhibits electronic commerce. Hence, from at least one perspective, it seems questionable as to whether the presence of these emerging institutions provide obvious benefits to Internet consumers.[67]

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[66] More specifically, sellers determine prices by employing either a) a "game-theoretic strategy", which is analogous to the theoretically derived results, b) a "myoptimal strategy", in which firms adjust their prices in discrete time, conditional on static expectations about other firms' behaviors, or c) a "derivative-following strategy" in which firms randomly experiment with prices, without knowledge of other firms' behaviors and/or consumer demands, and adjust their prices in the direction which yields them greatest profits.

[67] Varian (1999b) speculates that the rise of price-matching devices such as shopbots will lead to firms differentiating their products on grounds other than price. Among the forms of differentiation that are likely are consumer-specific versions of a given product, as well as loyalty programs for shopping with a given merchant.

3.4 Future of Sales Assistance

Addressing Bakos' (1998) claims about the functions of a market, it can be argued that one of its primary purposes is to facilitate "the exchange of information". The information that is exchanged in transactions is of the nature discussed above: product quality and price information. Central to providing such information in traditional transactions are sales assistants, who have acquired expertise in their product areas so that they can offer useful information that helps potential customers with their choices. A question being posed recently is: how will the proliferation of the Internet affect the sales assistance sector of the economy? Given that the transaction costs associated with information acquisition by consumers are significantly reduced, will traditional assistants be able to maintain economic viability in the future?

In trying to answer this question, one might turn to recent studies investigating the presence and need for expertise and assistance in markets. Wernerfelt (1994) presents a model involving buyers and sellers who are engaging in a "matching game" over product qualities and prices. More specifically, the model is a sequential game where in the first period, a seller learns the types of products he has available for sale, in the second stage a buyer communicates his preferences, in the third stage the seller identifies the proper match for the buyer and makes a take-it-or-leave it offer for the product, and finally, the buyer accepts or rejects the offer. Wernerfelt notes that there are numerous ways to communicate the relevant information for matching (e.g., printing brochures, salesperson monologue, dialogue, etc.), and each method has varying costs accompanying it. Conditional on certain assumptions being satisfied, Wernerfelt shows that dialogue between seller and buyer can lead to the most efficient outcome (with respect to both cost and product matching). Furthermore, with respect to active sales assistance more generally, Wernerfelt concludes that sales assistance is more likely to thrive as an institution where products are varied and possibly complicated, many buyers are uneducated (technically speaking), and the cost of a sales assistant's time is lower than the buyers'.[68] If these latter conclusions hold true, then it is unlikely that one will see complete migration of all goods and services to Internet where they will be sold in an automated fashion. For certain products, even though information acquisition will be reasonably costless, a consumer might still require input from an expert/sales assistant to ensure that he is making appropriate purchase decisions.[69]

Investigating a slightly different question, Biglaiser (1993) studies how different markets for durable goods can encourage the institution of the "middleman". By "middleman", Biglaiser is referring to any intermediary who purchases a durable good from one individual and sells it to another buyer, without changing it in any identifiable manner or affecting its value in any de facto manner.[70] Recognizing that in the absence of some sort of credible signal of quality for a given product, the market for durable goods will quickly collapse into the market for lemons (Akerloff 1970)[71], Biglaiser shows that the presence of a qualified middleman in the market, who is known for his expertise, can serve to enhance aggregate welfare by providing a credible signal about the quality of particular goods (i.e., resolving the adverse selection problem) in certain

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[68] Wernerfelt also argues that sales assistance is likely to thrive in industries where unpleasant buying experiences can significantly influence future purchase decisions, and in cases where institutions can be created to give strong long term incentives to sales representatives.

[69] Moving beyond the need for sales assistance, concerns about the cost-effectiveness of Internet retailers might also prevent mass migration of all markets towards the web. While the popular press has argued that moving a business to the web significantly reduces inventory, and overall administration costs, such is not always the case. In studying the web-spinoff of Recreational Equipment Inc. (REI.com), journalist Leslie Kaufman (1999) notes that the requirement for skilled labor to maintain the website has led to consistent increases in operating expenses--even more so than the bricks-and-mortar outlets in some cases; leading one to suspect that not all web businesses may be significantly less expensive than conventional outlets.

[70] The typical example of such an individual would be a used coin salesman, who buys and sells coins from and to collectors, without actually altering the material value of the coin in any way.

[71] That is, because buyers cannot differentiate between "high" and "low" quality goods, owners of high quality products, knowing that they will be unable to sell their good for its true value, will refuse to enter the market, leaving only goods of low quality (lemons) in the market.

markets. Specifically, he finds, in equilibrium, that if a middleman exists market segmentation will ensue, in that all high quality goods will pass through the middleman, whereas all low quality goods will be sold on the open market from owner to buyer. Furthermore, in such a regime the middleman will receive a high enough price for his services that he will not shirk by selling goods of low quality. Finally, these results will still hold even if the investment required by the middleman to establish his credibility as an "expert" is extremely high. As to where one might expect to see middlemen, Biglaiser's conclusions are unsurprising: where there are many low-quality goods in the market, and there is a notable difference in quality between "high" and "low" quality goods, yet it is difficult to discern relative quality levels from casual inspection. Such conclusions seem to strengthen the argument that at least for certain types of goods, widespread person-to-person sales via the Internet, absent any sort of intermediation, is not very likely.[72]

Considering empirical studies dealing with this issue in the context of the Internet, Bailey and Bakos (1997) consider the market activities of thirteen firms that are engaging in electronic commerce in order to determine how the proliferation of electronic markets might affect the intermediate channels between producers and consumers.[73] Examining a sample of both information goods and conventional goods retailers, the authors examine, specifically, whether electronic markets lead to "disintermediation". In other words, does the reduction in transactions costs that accompany electronic markets effectively eliminate the need for intermediaries

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[72] This conclusion is especially reasonable given that casual forms of inspection that are usually available during person-to-person sales are impossible on the Internet. How many people would feel comfortable buying rare coins or stamps from a personal collector having been unable to even look at them in person? An example of where intermediary institutions have emerged to solve this problem on the Internet is the market for collectible baseball cards; where before being posted for sale on the web, cards are inspected by independent grading agencies, graded appropriately, and then encased in plastic with a stamp indicating the grade and grading house.

[73] The sample was constructed by members of an MBA class at the MIT Sloan School of Management entitled "Electronic Commerce and Marketing on the Internet" as one of their course requirements. Class members prepared detailed reports about sample companies consisting of surveys and, at times, interviews with management executives.

between producer and end-user? Looking solely at the sample considered, it appears that the need for certain intermediary roles such as product aggregation and certain infrastructure-related facilitation activities are significantly diminished in electronic market settings. While these functions seem to fall by the wayside however, it seems that there is still a great, if not greater, need for intermediaries to provide services to create consumer trust, and, in some cases, to facilitate matching between buyers and sellers. Because of the sampling size (and methodology), such analysis is obviously preliminary and should be interpreted with caution. That being said, these last two trends seem to support the theoretical results laid out by Biglaiser and Wernerfelt, arguing for the viability of intermediaries in electronic markets[74].

3.5 Summary and Implications

When considering the existing body of work that either directly or indirectly pertains to electronic commerce, it seems evident that the Internet will have a significant long-run effect on the way commercial transactions occur. That being said, the logical question that arises is: to what end? Once electronic markets have matured, will lowered search costs and price-matching policies lead to something approximating marginal-cost pricing? Does the ease of monitoring firms' pricing policies necessarily facilitate vigorous competition? From a consumer standpoint, one might wonder if firms will be able to effectively engage in price discrimination by more sophisticated methods than those exhibited by Books.com as they become better educated about their consumer base.

On the matter of how lowered search costs will affect consumer prices, theoretical results offer no conclusive implications. As shown above, information-based pricing models can justify pricing policies that range anywhere between marginal cost to monopoly levels. Because many

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[74] A related topic that has recently attracted much attention in the popular press is the development of "infomediaries". Generally speaking, infomediaries are electronic intermediaries that, equipped with specific information about a consumer's tastes, income, etc., serve as computerized agents for the consumer in identifying and purchasing appropriate products and services. For a non-technical overview of the potential for such institutions, see Hagel and Singer (1999).

models fail to distinguish between the various functions of information and advertising (e.g., price information, product information, information about firm reputation, etc.) one is unsure about how decreasing search costs will affect each of these elements (and their interactions), and their subsequent effects on prices. From an empirical perspective, the evidence is mixed as to whether marginal cost pricing will ever be achieved. While Brynjolfsson and Smith (1999) note the presence of lower prices, and less price dispersion on the Internet for certain markets, such findings do not seem to be a general phenomenon. First, Brynjolfsson and Smith note that their findings about price dispersion are not robust to various specifications, and evidence from other markets might add to skepticism. For example, in studying the market for airline tickets, Clemons, et al. (1999) have found prices offered by online ticket agents can differ by as much as 18-28%, depending on how one controls for qualitative differences in the tickets.[75] Second, in considering absolute price differences between the online and offline world, the evidence is also sketchy. Lee (1998) has shown that in the Japanese used car auction market, price levels are consistently higher in electronic markets than offline auction blocks.

Faced with the empirical realities of the persistence of high prices and price dispersion, the question again turns to, what might be generating these outcomes? A variety of explanations can be posited, but to observe such pricing patterns in markets for homogenous goods, it seems that there might be some truth in Smith, et al.'s (1999) claim that reputation is a likely cause.[76] To illustrate their point, the authors point out that several customers who regularly employ shopbots will persist in purchasing from retailers such as Amazon.com that post consistently higher prices than their shopbot findings. While Amazon.com might not have the lowest prices, it is well known for it's prompt delivery practices, and general widespread acceptance as a legitimate business actor; and it is these qualities that might be driving transactions.

[75] While the authors do not compare these prices with offline counterparts, Smith, et al. (1999) note that "the amount of dispersion they find is higher than one might expect."

[76] Clemmons, et al. (1999) attribute the observed price dispersion to concerted efforts to engage in price discrimination, in conjunction with differing degrees of product differentiation, rather than any sort of reputation effect, per se.

On the web, which is a transactions medium that is, by construction, relatively devoid of personal contact, it seems likely that intangible qualities such as brand recognition could define consumers' demands more so than price. Hence, a firm that possesses a "high quality" brand name might have the luxury of consistently pricing above most of its competitors, because it realizes that consumers will still choose to shop with them over their lower priced competitors.[77] It seems reasonable, then, that new firms will seek to establish brand name and firm reputation by such means as aggressive advertising and free promotions, in efforts to expand market share and achieve a position where higher prices can be charged commensurate with the reputations gained. Closely related to the value of a brand name are the actual pecuniary benefits that a consumer accrues by continuing to shop with a particular retailer. As noted by Shapiro and Varian (1999) and Varian (1999a), various loyalty programs such as discounts for repeat shoppers, can serve to effectively "lock in" prospective consumers with particular retailers.[78] Once customers are locked into a loyalty program, retailers may have some (albeit possibly limited) latitude with which they can exercise market power.[79]

While firm reputation and loyalty programs might prevent widespread convergence in prices, price-matching policies can serve to stimulate the "race-to-the-bottom". As to whether such policies might actually enhance consumer welfare is an open question. Disagreeing with conventional notions of how price-matching might harm consumers by facilitating collusion, Corts (1996) considers a model in which he shows that price matching policies can, in some cases, unambiguously enhance consumer welfare. While such findings might call into question

[77] The empirical implication of such a theory is that the more well-known online retailers will consistently price higher than less well-known retailers. At least in the market for books, Brynjolffson and Smith (1999) show that this trend holds true.

[78] For example, while it existed, "Books.com" rewarded "bookmark points" to customers for every dollar spent at the website, which could be redeemed for discounts towards future purchases.

[79] The validity of this statement necessarily rests on the requirement that the prices being charged by a given firm trying to exercise "market power" are still less than the costs to a consumer of switching and foregoing the benefits of the respective firm's loyalty program.

those less optimistic findings that support the emergence of collusion (Salop 1986)[80], certain features particular to the Internet might weaken the strength of this finding.

First, as noted by Kephart and Greenwald (1998), price matching, if conducted by shopbots, could lead to the unpleasant externality of Internet congestion. Therefore, if all firms are trying to match each other by using shopbots, the entire web might suffer at times, and hence, it is inappropriate to say that consumers will "benefit" from widespread adoption of price matching.[81] Second, given that monitoring costs on the Internet are negligible, this could facilitate efforts to coordinate prices. If the field of Internet retailers of homogenous goods shrinks to relatively few in number, it seems plausible that price coordination might emerge, using shopbots as a monitoring device, to keep prices set just above the point that widespread migration to bricks-and-mortar outlets is prevented.[82]

On a related issue of how prospects for price discrimination might affect consumer welfare, the verdict also seems mixed. On one hand, price discrimination, in certain situations, can be shown to enhance welfare by expanding the potential market for certain products. With respect to the provision of information goods in particular, it seems that the Internet can easily facilitate the practice of "versioning" (Shapiro and Varian 1999, Varian 1999a) products, or selling identical goods of varying quality (a.k.a. "damaged goods" ala Deneckere and McAfee 1996) that can lead to a substantial expansion of the potential consumer base, enhancing aggregate welfare. On the other hand, Chiang and Spatt (1982) has shown that if firms implement price discrimination by tying lower prices to delay (e.g., longer search processes,

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[80] Salop (1986) cites price-matching, and meeting competition clauses specifically, as a practice that can "facilitate oligopolistic co-ordination".

[81] Of course, the plausibility of the claim that shopbot proliferation will clog up the Internet is an empirical question that requires further study. Simulation exercises might help provide information as to whether this is a realistic possibility.

[82] One would expect that cyclical price wars would be associated with such coordination as firms that attempted to defect and lower prices, were quickly detected and then punished.

hunting through numerous menus, etc.), then welfare effects are ambiguous; and for certain cases, the outcome is socially inferior to a competitive outcome.

Welfare effects aside, with additional prospects for price discrimination come prospective lawsuits alleging discrimination. Currently, business-to-business transactions on the Internet account for a substantial portion of electronic commerce. Estimates for total business-to-business transactions range from 40% (Goolsbee and Zittrain 1999) to 80% (Cline and Neubig 1999b) of all commerce conducted on the web. While price discrimination from business to end consumers is not per se illegal, suppliers discriminating between retailers or secondary suppliers could be violating the Robinson-Patman Act. With the technological innovations discussed in the above sections, it seems likely that primary suppliers might be able to be better informed about their consumer base than ever before, and hence be able to extract differential rents from customers as a function of their willingness to pay. In the event that the customers are competitors in a secondary market, then the retailer could be subject to antitrust liability.

Other fields in which competitive concerns might arise include the issue of bundling of content and services. The studies discussed above provide theoretical efficiency justifications for such bundling, but such results may not compensate for anti-competitive concerns associated with such activities. As more firms seek to offer wider and better-integrated services to attract users, questions will arise as to whether the provision of such goods serves to weaken competition. Competition issues aside, as electronic commerce matures and more data become available, there are several possible directions for future research. First, and most obvious, it would be interesting to analyze whether the price differences (or lack thereof) between online and offline firms become a robust phenomenon across all markets. In the event that certain markets still exhibit higher online prices, one might seek to address what, specifically, about different markets might facilitate a price differential favoring bricks-and-mortar outlets. Along these lines, future research might focus on more large-ticket items such as automobiles and consumer electronics, where repeat buying is less frequently observed (or where there is a lengthy period between purchases). For such items, loyalty programs, for example, should not affect consumer choice, so it would be interesting to analyze whether lower search costs do, in fact, lead to lower prices.

Closely related to these issues, it should be noted that prices on the Internet might not be accurately reflecting the welfare benefits that consumers receive from shopping online. When one takes into account the convenience associated with delivery and the appeal of customized orders, it is reasonable to argue that despite marginally higher prices, consumers are still better off purchasing products online. Future research might explore this perspective by developing welfare measures that accurately reflect consumers' web experiences, and that do not solely rely on product price data.

Another research possibility is to examine the extent to which the ability of firms to engage in price matching facilitates de facto collusion. By programming a shop bot to collect pricing data from several stores (either small or large items), one can easily compile a rich database with which to discern pricing patterns that might suggest price coordination and/or retaliation for deviations from a price agreement.

A fourth area of research is to examine the extent to which the Internet is effectively serving as a clearinghouse for relatively hard-to-move durable goods. Given the information-rich environment of the Internet, one might expect that certain goods should be transacted more often on the Web than in the real world, as more interested consumers are able to become better informed about the potential product offerings available on the Internet. Specifically, one might expect that the market for second-hand goods would flow more freely on the Internet than in the offline world, as consumers would no longer be effectively limited to product choices in local markets. Comparisons between online auction sales and sales through classified ads or second-hand specialty stores (disregarding the middleman problem for a moment), would help clarify whether the Internet truly helps facilitate the realization of "frictionless commerce".

Section 4: Network Effects and the Internet

Schmalensee (1995) defines a network as "a set of nodes connected, directly or indirectly, by a set of links", and argues that a defining characteristic of a network "is the presence of 'network externalities'". In simple terms, a good is commonly referred to as possessing network externalities if the value of the good to an individual user increases as more individuals use it. In discussing the Internet, the concept of network externalities has been popularized in a statement known as "Metcalfe's Law", which roughly claims that the value of a given network is proportional to the square of the number of its users.[83]

The most straightforward example of a product that possesses network effects is a communications network such as a phone system or a fax machine: with only one user, it is basically worthless, but as more people come to own phones/faxes, the value of the system, and the consumer demand associated with it, increases significantly. Early research by Farrell and Saloner (1985) and Katz and Shapiro (1986) draw a distinction between direct and indirect network effects. In the case where the product in question is a communications network, the value associated with the growth of the network can be classified as direct: the more people that become part of the network, the more people one can communicate with, and hence, the more valuable the network is to a given user. An alternative possibility however, is that the positive network effect is indirect, as is usually the case with consumer electronics technology and computer systems. As more individuals purchase CD players or a given operating system, suppliers of technological compliments (e.g, CDs or software) recognize the increased value associated with the network and increase the production of these necessary components accordingly.[84]

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[83] "Metcalfe's Law" is named after Bob Metcalfe, the inventor of the Ethernet (Shapiro and Varian 1999, p. 184).

[84] Shapiro and Varian (1999) present examples of success and failure stories about various products, such as betamax standard videotapes, and ATM's, that possessed network effects, and whose markets expanded or contracted based on consumer expectations about the

As noted in Varian (1999b), the value of a given communications network such as a phone system rests on the fact that all phones use a common communications standard such that any member of the network can communicate with another member. This argument would also apply to the Internet, as the communications protocol (TCP/IP) serves as a de facto open standard between completely disparate networks, allowing members from different networks to connect with each other without actually belonging to each others' networks. In allowing such interconnection, the Internet truly serves as a "network of networks." That being said, one should expect that the conventional economic principles that apply to networks should also apply to the Internet; whether one is considering interconnection agreements, technological innovation, or electronic commerce more generally.

Unlike the previous two sections, there has not been a substantial amount of recent literature written that specifically addresses the role of network effects in the context of the Internet. A sizable portion of the existing literature focuses on subjects such as network effects in technology adoption, strategic pricing policies by firms, and efficient network size. Recent scholarship has often incorporated these earlier findings to study network effects and emerging information technology more generally, with possible applications to the Internet. Because of this dearth of Internet-specific literature, this section will focus primarily on discussing the traditional literature on technology innovation, and then turn to more recent literature (where it exists) on Internet and technology-related matters.[85]

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future size and scope of the network associated with the good. In contrast, Liebowitz and Margolis (1994) argue that the failure of many products, the betamax standard in particular, might have been due to poor management decisions rather than any sort of network effects.

[85] The body of literature that can generically be classified as dealing with "network effects" is quite broad. Only a minute portion of the literature will be discussed in this essay. For a more extensive treatment of the subject, see Tirole (1988), particularly chapter 10, for a list of relevant references. Economides (1996), and Katz and Shapiro (1994) also provide detailed overviews on the literature pertaining to the economic issues surrounding networks and vertically related industries.

4.1 Network Effects and Technology Adoption

One of the first, and more influential studies of network effects in the context of technology adoption is Rohlfs (1974). Noting that for a generic "communications system", the utility of a given subscriber increases as more users are added to the network, Rohlfs sets out to determine the equilibrium user set associated with such a network; and to analyze under what conditions such an equilibrium can be achieved.[86] Employing a very general framework, Rohlfs finds that for any given price, there are multiple possible equilibria that may emerge; and the realization of a given equilibrium is determined, in part, by the size of the initial network. More specifically, the "viability" of a given equilibrium is a function of the initial network size. If the number of initial users is "large" enough (as defined by the theoretical results), then the system is said to possess "critical mass", and is guaranteed to eventually converge to an equilibrium user set. Conversely, if the initial user set is below critical mass, the equilibrium will not be realized.

Having established a distinction between potential and realized equilibria, Rohlfs provides several possible strategies that firms (or other service providers) might employ to solve the "start-up problem" such that critical mass is achieved. Among the options discussed are giving the product away and/or providing it for a low introductory price to potential users.[87] In addition, Rohlfs makes the interesting point that the presence of small communities or interest groups can help ameliorate the difficulties associated with achieving critical mass (assuming that the communities adopting the product en masse are large enough, in the aggregate, to achieve critical mass).

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[86] Rohlfs defines the equilibrium user set simply as "the set of users consistent with all individuals' (users and nonusers) maximizing their utilities."

[87] Rohlfs recognizes that inefficiencies are likely to follow the implementation of a single low introductory price, as low-valuation consumers are likely to drop out of the network as the price is raised following widespread adoption. In order to ensure that the equilibrium user set is realized, Rohlfs proposes price discrimination as a possible solution.

In considering the theoretical plausibility of the pricing strategies suggested by Rohlfs, Cabral et al. (1997) focus on what kind of pricing policies might be employed by a monopolist that is producing a good with network effects. More specifically, the authors seek to answer whether the Coase conjecture will always hold for durable goods. That being, whether it is true that the price posted to first-period consumers is necessarily higher than any price posted for subsequent-periods. Considering cases in which consumers are “small” and “large” with respect to their influence on the network, Cabral et al. finds that under certain cases, the presence of network externalities can facilitate penetration pricing in which prices for new products are lowest at their time of introduction: even in the absence of any sort of competition. This result confirms Rohlfs’ suspicions that such strategies may help firms develop a viable installed base. Consistent with this revelation, the authors note that their findings provide a theoretical explanation for the pricing trends that were observed with Compuserve and Prodigy: two Internet service providers that were priced lowest upon debut, and then consistently increased to a stable plateau as more members subscribed to their services.

Investigating similar issues as Rohlfs in a competitive setting, a series of papers by Katz and Shapiro (1985, 1986) and Farrell and Saloner (1985, 1986) study the issues of standard setting and technology adoption in various markets where network effects are present.[88] Katz and Shapiro (1985) present a static model of oligopolistic competition where consumers’ utilities for a given product are explicitly defined as a function of its price, the consumers’ “types” and the number of consumers that use the product. In their model firms decide how much of their product to produce, as well as whether to make it technologically compatible with other products. The equilibrium concept employed is “Fulfilled expectations Cournot equilibrium” (FECE), which implies that a given firm chooses its output level conditional on the belief that a) consumers’ expectations about the network sizes are common knowledge, and b) competing firms’ outputs are fixed. Similar to Rohlfs, they find that multiple equilibria may be realized, conditional on consumers’ expectations about potential network size. Hence, the success of any

[88] See Besen and Farrell (1994) for a nontechnical discussion of various strategies that firms might employ in standard setting competitions.

given network becoming the dominant standard is very much a self-fulfilling prophecy depending on whether consumers believe that the standard's dominance is plausible.

Besides focusing on existence, the authors also consider a firm's strategic choice about whether to institute compatibility with other firms. As might be expected, those firms that are large, and have a strong consumer base, will tend to favor compatibility less than those firms with weaker consumer bases--regardless of social welfare considerations. The authors note that under certain conditions, widespread industry compatibility may be welfare-enhancing over incompatibility, and that institutions such as side-payments between firms and industry coalitions may serve as mechanisms to foster such compatibility. While such mechanisms may have adverse effects (e.g., competition-chilling cartels), the authors note that a policy argument can be made for antitrust exemptions in such cases where industry "cartels" are likely to yield welfare-enhancing compatibility decisions for their products.

Similar in focus, Katz and Shapiro (1986) consider a two-period model where consumers are choosing between adopting one of two incompatible technologies, either of which may be sponsored. A technology is "sponsored" if a producer has some sort of proprietary rights over the technology, such as a patent, that might allow him to price the product at something other than competitive levels. In the absence of either technology being sponsored, the authors find that both technologies will be subject to marginal cost pricing, and (unsurprisingly) because of the existing network externalities, the competitive equilibrium will likely be inefficient from a social welfare standpoint. This outcome changes dramatically, however, when one or both technologies are sponsored. Similar to Rohlfs and Cabral, et al., the authors find that when one technology is sponsored, the sponsoring firm might be able to create a solid established base in the first period by engaging in below-cost penetration pricing that will lead to its technology being the dominant standard in the second period. While such standardization might prove optimal over the competitive outcome, the authors note that sponsorship could yield suboptimal outcomes, in that the "wrong" technology can be adopted from a social welfare standpoint.[89]

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[89] This somewhat perverse result is possible because the sponsoring firm might price their technology so far below cost in the first period that all first-period consumers adopt it.

Finally, the authors note that for the case where both technologies are sponsored, the rational expectations of consumers can lead to the normatively desirable outcome that the technology that would be superior in future periods is made the standard, despite a cost differential that favors an inferior technology in the current period.

A question that arises when considering the Internet is how feasible is it for new standards/technologies to emerge (e.g., the current question over different formats for digitized music) that can displace entrenched products. This question is addressed in a paper by Farrell and Saloner (1986) where they investigate whether a new technology can emerge as the dominant standard in the case where there currently exists an incompatible installed base. In trying to answer this question the authors present models in which users (either users of old technology, or those who are altogether new to the market) are choosing whether to adopt a new technology. In the case where new users are choosing what technology to adopt, the authors find that equilibria exist where the new technology both is, and is not, adopted as the dominant standard. In the simple framework of their model, their results imply that the primary factor that determines new technology adoption is the size of the installed base that favors the old technology, and the perceived benefits of the new network. Hence, while not a general property of products with network effects, one can find cases in which the installed base of the old technology can effectively be viewed as a barrier to entry.

Realizing how installed bases can dissuade entry, Farrell and Saloner note that firms, both incumbent and entrant, might take certain, arguably anticompetitive, steps to try to either bring a new technology to market, or keep a competitor off the market altogether. From the perspective of the incumbent producing the old technology, the authors note that various "predatory" pricing schemes might be an effective way to expand their installed base to prevent

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Conditional on the size of the first period network being sufficiently large, second period consumers will also adopt the sponsored technology even if it is priced higher than the unsponsored technology and less desirable.

entry of the new technology.[90] Alternatively, an entrant might attempt to stall the expansion of the incumbent's installed base by preannouncing their technology prior to release. By conducting a product preannouncement, new users, realizing the potential benefits of such technology, might choose to wait for its release, rather than accept the current standard. Such a phenomenon can lead to cases in which new technologies are adopted where they otherwise might not have been, absent such an announcement.[91]

Disregarding the issues of market competition altogether, Farrell and Saloner (1985) focus solely on the question of when it is possible for network externalities to cause the "stranding" of industries in old standards that are inferior to new technologies. Considering a model of technology adoption where *N* firms make a discrete, sequential choice of whether or not to adopt a new technology, the authors find that the answer to their question hinges profoundly on the amount of information available to the firms at the time of their decision. For the complete and perfect information case, where firms are fully aware of the relative payoffs of all industry players from adopting a particular new technology, the authors show that in equilibrium, all firms in the industry will switch to a new superior technology, if such technology

[90] The authors point out that there are cases in which an entrant might be priced out of the market despite the fact that an incumbent is not engaging in predatory practices as defined by the conventional standards of Areeda and Turner (1975) and Ordover and Willig (1981). Suppose for example, that the incumbent firm is a monopolist, and upon witnessing an entrant trying to bring his technology to market, he cuts his price below the monopoly price, but still above marginal-cost pricing. Furthermore, assume that this price cut causes the incumbent's installed base to expand substantially. Such expansion might prevent an entrant from ever penetrating the market, after which the incumbent could raise his prices again to the monopoly level. Such a situation is arguably anticompetitive, and cannot be accounted for by the conventional standards for predation because a) the incumbent is still pricing above average variable cost (Areeda and Turner), and b) reentry costs are irrelevant (Ordover and Willig).

[91] In addition, the authors can point to examples in which product adoption following from such a preannouncement might actually be a social welfare-reducing phenomenon; because the welfare loss to those consumers that are stranded with the old technology is far larger than the welfare gain that accrues to the new technology adopters.

is available; and hence, there will be no “excess inertia”.[92] Unsurprisingly, the authors find that for the incomplete information case, where firms are less certain about industry switching dynamics, equilibria can arise where the industry fails to adopt a new technology despite the fact that such adoption would be best for society (Pareto optimal). Finally, the authors note how the introduction of communication prior to an adoption decision can lead to a stable outcome wherein efficient industry adoption prevails.[93] Given that many would argue that current market conditions are representative of an incomplete information environment, such results imply that there is a potential for stranding in the context of the Internet.[94]

4.2 Applications to the Internet

Having discussed a small sample of the existing literature on network externalities, the question naturally turns to: what does this mean for the Internet? More specifically, given the network properties associated with the Internet, are there things particular to the Internet that might warrant special attention from antitrust agencies? Before answering this question, it is important to note that it is difficult to identify any sort of application that exhibits obvious network effects that is unique to the Internet. That is, many of the Internet-based applications that seem clear candidates for having network externalities (e.g., shared databases), have bricks-and-mortar counterparts that exhibit many/all of the same properties. Having said that, the following discussion of implications for the Internet necessarily applies to conventional network industries as well.

One of the more likely venues for potential anticompetitive problems is the Internet

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[92] By “excess inertia” the authors refer to the phenomenon where the entire industry would prefer to switch to a new technology, but fails to do so.

[93] The equilibrium concept adopted in deriving this latter finding is Perfect Bayesian.

[94] This point should not be overstated. As noted by Katz and Shapiro (1994), “there is no general result implying excess inertia in market equilibria.” Because of the existence of multiple equilibria, it is impossible to objectively determine the conditions under which a particular market/industry may become “stranded.”

infrastructure. Considering the issue of network architecture, White (1999) argues that "even if competition is present in most of the components of a network, monopoly in just a single component may be sufficient to capture all the potential rents from the transactions that use that component." In the context of the Internet, a parallel can be drawn between these theoretical results and the current state of interconnection agreements between regional networks and backbone providers.

While most backbones currently do not charge for network interconnection between backbones, backbone to regional networks connections are usually established on a fee-per-connection basis, where the smaller network would appear to have limited bargaining power.[95] Given that the backbone owners may arguably possess an essential facility in the conventional sense, there are several competitive concerns that might arise when considering the prospects for infrastructure development. First, as backbone owners begin to provide integrated services, such as acting as an ISP to end users, one might fear that competition will be lessened as backbone providers could raise interconnection fees so high that they effectively foreclose potential competitors for ISP services from the market. While such a scenario may have some plausibility, theoretical results from Economides and Woroch (1992), and Ordover and Willig (1981, 1999), imply that a more likely outcome is one in which backbone providers attempt to engage in some manner of price discrimination to "squeeze" as much value as possible from those firms that must rely on their technologies.[96] Similar to the issues presented in Section 3,

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[95] Concerns about network interconnection fees, and possible service degradation, surrounded the 1999 MCI-WorldCom merger, where the combined firm would have been a dominant backbone provider. Litigation was avoided by MCI divesting their Internet business to a third party, thereby preserving a "rough parity" among existing backbone providers (Melamed 1999, Robinson 1999). There is a substantial body of work dealing with the economics and technical details surrounding settlements and interconnection agreements on the Internet that overlaps with the topics discussed in Section 2. For a treatment of such issues, see Bailey (1997), Herzog, et al. (1997), Lehr and Weiss (1996), and Srinagesh (1997).

[96] Of course, any sort of "squeeze" may require some sort of price coordination on the part of the backbone providers.

these possibilities for price discrimination might require some sort of antitrust enforcement on the part of the relevant agencies.[97]

Besides the possibility of price discrimination at the bottlenecks, there are several other developments that might warrant the attention of antitrust authorities in future years. Lemley (1996) considers the issue of standardization and its implications for the Internet. Noting the inherent network externalities associated with the Internet, combined with the value of product interoperability and the presence of notable resource commitments on the part of investors and consumers, Lemley claims that standardization, at one level or another, is inevitable. Furthermore, he argues that this standardization will likely lead to the rise of natural monopolies providing one group of widely-adopted products "with market durability that may significantly outlast the competitive superiority of the products." While he believes that the software industry is not a natural monopoly, per se, the natural tendencies towards standardization, combined with consumers' expectations about market position may render competition somewhat inefficient.

Given that consumers might be harmed in a "winner-take-all" battle for standards, Lemley argues that it would be worthwhile to consumers and industry to ensure that competing standards are interoperable. Such interoperability might be achieved through existing intellectual property laws, government mandate, or industry-wide adoption of a universal standard.[98] With respect to the basic communication protocol, the private sector has obviously been successful in navigating the standard-setting minefield. That being said, with the impending introduction of technologies such as network-based applications, it seems likely that questions will arise over which standards to implement vis-a-vis operating systems and the Internet to make such

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[97] Unlike the matters covered in Section 3, however, any price discrimination that might occur vis-a-vis backbone providers and regional networks would not be subject to Robinson-Patman enforcement because Robinson-Patman only applies to markets for tangible goods, and is not relevant for service provision, such as backbone access.

[98] Lemley notes the complications that exist with all of these options, ranging from government ignorance about the relevant technologies to the possibility of industry-group coercion on the part of a dominant firm.

applications function efficiently. In such a situation, Lemley would argue against "condemnation" of industry standard-setting coalitions that often raise red flags for regulators. While it is true that such organizations could potentially foster anticompetitive cartels, Lemley agrees with Katz and Shaprio (1985), when he notes that the benefits that could follow from information sharing and the industry consensus might ameliorate the usual anticompetitive concerns.

Focusing on exclusivity provisions in networks, Balto (1999) argues that products and systems exhibiting network effects should be subject to heightened scrutiny from antitrust authorities because of the ease with which market power can be established relative to normal goods.[99] In particular, Balto argues that exclusivity provisions could have the anticompetitive effects of foreclosing new entrants, in that they effectively raise another barrier to entry in a given industry.[100] Such foreclosure, in turn, could potentially stifle innovation, as entrenched market leaders would not feel the competitive pressures to offer new products to maintain industry dominance. To prevent such harms, antitrust authorities need to address the issues of market definition and de facto market power, realizing that the presence of a relatively small installed base might make a given firm far more entrenched than they otherwise would be, absent the presence of network effects.

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[99] In writing this article, David Balto was expressing his own views, and did not necessarily reflect the views of either the Federal Trade Commission or any individual Commissioner.

[100] An example of such a provision might be some sort of joint venture exclusivity whereby members of the joint venture agree not to compete with the network, either by themselves or as participants in alternate networks. Balto cites the formation of the Florist Telegraph Delivery Association (FTD) as an example of a network that employed such an exclusivity provision. Shapiro (1999) also discusses the effects that exclusivity provisions in network industries might have on the propensity for firms to enter a market. Similar to Balto, Shapiro argues that while exclusivity provisions can, in theory, be pro competitive, the presence of network externalities might lead to decreases in welfare that would overwhelm whatever procompetitive effects would normally follow.

In the context of the Internet, one might consider the recent debate that has arisen over developing uniform standards for digital music downloads. The effort is currently being coordinated by a recording industry consortium (Richtel 1999), and if members of this coalition were to agree to certain protocols and standards, but not make the applications available to all music producers, then such actions might likely yield anticompetitive effects that could warrant government attention.[101] Another example of standard setting competitions is the debate that ensued between America Online (AOL) and Microsoft in the fall of 1999 over Instant Messenger networks. As reported in The Washington Post (Chandrasekaran 1999a), Microsoft attempted to provide its 4.5 million Microsoft Network (MSN) members with access to AOL's Instant Messenger service so that MSN members could communicate with AOL's members. According to the report, AOL, in trying to maintain exclusivity to its standard, began blocking MSN's attempts at compatibility. After developing over two dozen versions of its Messenger software, each of which was successfully blocked, Microsoft gave up in November, 1999, citing concerns about security as the reason to end the battle. Despite the drawn out conflict between the two firms, both AOL and Microsoft publicly pledged to develop a compatible protocol for their two systems to ensure interoperability.

In addition to standard setting, government intervention might be relevant in the debate over universal access. As noted in the above models, a given technology, or system, can only become dominant in the case that there is a sufficient number of users such that "critical mass" is achieved. Given that virtually everyone sings the praises of the educational and economic benefits that come with Internet access, similar to earlier debates about telephony, a question has arisen over whether the government should become involved with subsidizing Internet access (e.g., the FCC's universal service fund) to ensure that it achieves widespread use. Politicians, scholars, and various advocates find themselves on all sides of this issue. For example, the Progressive Policy Institute, an arm of the Democratic Leadership Council, has stated that it should be the goal of the government to "provide sufficient free access to the Internet" such that

[101] Similar developments are occurring in the market for digital books, where industry representatives have been attempting to develop uniform standards for digitizing text for Internet transmission (Macavinta 1999).

all individuals will have access to emerging technologies and realize the benefits of the developing network (Atkinson, et al. 1999, p. 40). On the other side of the issue, Shapiro and Varian (1997) are skeptical as to whether government should be involved in providing access, arguing that current rates of telephone penetration might have occurred even without government intervention. White (1999) argues more strongly against mandating universal access, claiming that such mandates are "almost always antithetical to efficient pricing and ultimately to competition."

On the separate question of whether or not it is appropriate to provide special treatment to firms, through either subsidization or monopoly protection, in order to help achieve critical mass, Shapiro and Varian (1997) argue that it may be very worthwhile for the government to sponsor "demonstration projects" to stimulate interest; however, "one should not underestimate the ingenuity of the private sector in dealing with network externalities". In other words, the private sector, more often than not, should be able to overcome the coordination problems associated with introducing new systems of products and establishing a market presence. Their sentiments are similar to the theoretical findings of Economides and Himmelberg (1995) who, in studying the evolution of the fax machine market, inquire whether a monopoly, oligopoly, or competitive market will be more successful at achieving critical mass. Central to their findings is that the point at which a market obtains critical mass is independent of market structure. Hence, in the absence of any sort of external coordination by nonmarket forces, monopoly, oligopoly, or perfect competition can theoretically produce equally desirable outcomes with respect to technology diffusion.

4.3 Summary and Implications

In considering the previous sub-sections, certain points are evident. First, there is obviously a sizable body of active research discussing general economic phenomena that can be classified as "network effects." Second, much of the research discussed may have implications for the development of electronic markets, and the Internet more generally. The previous sub-section pointed to several examples of how the research covered could be relevant to Internet-related matters, and while such examples seem thought provoking, it should again be noted that many of these applications (e.g., database access, communications systems, uniform standards) have easily visible bricks-and-mortar counterparts. Having said this, in viewing the rapid developments of new technology, a question that naturally arises is: to what extent do network effects actually exist? (Liebowitz and Margolis 1994). This leads to a related question: is there any empirical evidence that would lead one to treat certain markets differently from others in trying to analyze the relative competitive effects of different market structures? If future empirical work were to show that network effects are merely theoretical concepts, then government antitrust authorities should treat Internet-related markets like any other sort of product market or distribution channel in determining the presence (or lack) of viable competition.

This concern speaks to the broader question of what, precisely, constitutes a network effect? Taken at the most base definition, one can provide a rationalization for why virtually any product/service/system can be said to possess network effects, but is such an expansive definition empirically accurate? For example, as noted by Liebowitz and Margolis (1994), the negative relationship between product price and network size is often cited as evidence of network effects,[102] but such a relationship could be following from any of several factors besides the presence of network effects, including something as basic as economies of scale with respect to the cost of inputs. Unfortunately, solely observing such trends as price and production levels makes it impossible for one to distinguish between observationally equivalent phenomena, each of which would justify different methods of government intervention (Liebowitz and Margolis 1994, p. 138)

There has been a sizable body of empirical work aimed at uncovering evidence of the presence of network effects in markets such as home computers (Goolsbee and Klenow 1999),

[102] For such a negative relationship to be observed, it would likely be the case that the "technological externalities" that follow from increased network size on the part of producers, are leading to cost savings that exceed the increases in value to individual consumers from network growth (the latter would usually produce an increase, not decrease, in price).

computer spreadsheet programs (Gandal 1994), and automated teller machines (Saloner and Shepard 1995). While these studies have been successful in showing that network effects may plausibly exist in certain markets, Liebowitz and Margolis' original concern still resonates: it may be very difficult to determine whether a given change in the relationship between price and market structure is a result of network effects or some underlying economies of scale particular to the market in question.[103]

In the United States, the exercise of lawfully obtained market power is not illegal. In the event that a firm is exerting market power to obtain supra-competitive profits, the relevant question turns to how the firm in question obtained and maintains such market power. Of the many methods available to a given firm, most possibilities fall into one of the following categories: Either a firm achieved market power because of some underlying economies of scale (that might lead to a natural monopoly), the production of a superior product, the existence of legal sanction (e.g., patents or licenses), the presence of network effects (e.g., "tipping"), or some sort of anticompetitive practice (e.g., exclusion or predation). If such power was created through the last channel, then current antitrust policy can address the problem.

Network effects, however, pose difficult problems for antitrust policy. First, as noted above, the difficulty associated with recognizing network effects as the source of market power might discourage enforcement for fear of taking inappropriate action. Second, even if a case can be made that market power follows from network effects, it may be difficult to identify how a firm's market dominance followed from its conscious exploitation of existing network effects through some sort of "attempt at monopolization".[104] Establishing this latter condition will likely raise a host of other, relatively messy, questions. For example, what constitutes predatory or exclusionary conduct, and how should entry barriers be evaluated in a market characterized by

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[103] The analysis conducted in the above studies does not require the authors to control for economies of scale.

[104] The Federal Trade Commission (Federal Trade Commission 1996, Ch. 9) explores these issues in the context of competition policy in high-tech and developing marketplaces.

network effects? These questions are not trivial, and they will likely confront antitrust authorities in the coming years as the Internet expands to touch more industries and channels of commerce. Future research might aim at theoretically (and empirically) distinguishing between market power that arises from normal competitive responses and market power that arises from anticompetitive exploitation of network effects. Such scholarship will be highly relevant to forthcoming developments of the Internet (and Internet-related industries) and can serve as a useful guide for government antitrust policy.

Section 5: Internet Taxation

Whereas previous sections of this essay have focused on Internet-related research that addresses pricing and market structure, this section will change direction by considering a topic which is at the forefront of recent legislative debates: Internet taxation. A question being voiced currently is: should the government impose new taxes upon Internet commerce? If so, which level of government should have taxing authority? How should a given taxation system be implemented? These and other questions have been the focus of an intensifying debate that has started to rage between small businesses, local governments, online merchants, and a host of other interests. This section will present a brief review of the legal and legislative history surrounding the issue, and then discuss some of the academic work that has been done on this matter. As will be seen, the question over whether electronic commerce should be taxed seems neither clear-cut, nor subject to obvious resolution anytime in the near future.

5.1 Legal and Legislative History

The current debate over Internet taxation has many parallels to the previous controversy over taxing mail-order catalogue sales. In considering transaction formats alone, at least for the case of physical goods, the two channels of commerce are virtually identical. Neither the Internet nor catalogue sales require any sort of bricks-and-mortar outlet for commerce to proceed. In both cases, a consumer might, in theory, be ordering from a company that keeps its stock in a nondescript warehouse, for the sole purpose of processing mail/e-orders. Even more extreme is the possibility that a consumer might be ordering from a company that owns absolutely nothing with respect to capital or inventory, and simply supplies orders on demand from producers to consumers. Given that consumers may be purchasing goods across state lines, questions have arisen over which body possesses the authority to collect taxes from such sales.

The question over whether remote sellers have an obligation to collect sales taxes from out-of-state buyers was addressed in two seminal Supreme Court cases: National Bellas Hess v. Department of Revenue of the State of Illinois (386 U.S. 753, 1967) and Quill v. North Dakota (504 U.S. 298, 1992). Without getting into the details surrounding these cases, their decisions established the current environment in which remote sales (i.e., catalogue) take place. Currently, companies cannot be compelled to collect sales taxes on those transactions that occur in a state where they do not have a "physical nexus"; which is loosely defined as a geographical presence. The same standard has been conventionally adopted for electronic commerce as facilitated by the Internet

While companies cannot be compelled to collect taxes on Internet sales that occur outside of states in which they possess a nexus, in most states individual consumers are still considered responsible for paying taxes. Specifically, in most taxing jurisdictions, consumers are subject to paying "use" taxes for goods that are bought outside of the jurisdiction in question. The use tax rate is typically the same level as the given jurisdiction's sales tax rate, and usually applied to the same sorts of goods as covered by the sales tax. While such an institution might allow local governments to retain the tax base that is theoretically being lost to mail-order or Internet transactions, it should be unsurprising that use taxes are somewhat ineffective. Most consumers are completely unaware that their purchases are subject to such taxes; and even if they are aware, the rate of compliance is very low. If local governments are to hold on to such tax revenue, therefore, it seems necessary that they be allowed to collect taxes on Internet sales in some capacity.

Beginning in 1997, state and local governments, concerned that consumer migration to the web would drastically reduce their available tax base, began considering and advocating

Internet-tax legislation. Their cause was strengthened by the interests of small businesses who were beginning to feel the competitive pressure of online stores, that were able to offer lower prices, at least partly due to a tax-advantage. Some state legislatures pushed forward and considered passing new legislation specifically for electronic commerce, which would allow them to tax remote sales.[105]

In response to this public interest and pressure**,** Rep. Christopher Cox (R-CA) and Sen. Ron Wyden (D-OR) introduced the Internet Tax Freedom Act (ITFA) in 1998. Passed as part of the Omnibus Appropriations Act of 1998, the ITFA placed a three-year moratorium on new Internet taxes and created the "Advisory Commission on Electronic Commerce" to study issues related to the taxation of the Internet. The Commission was to consist of nineteen members appointed by Congress representing business, the Federal Government, and State and local governments, whose term would expire in April 2000, at which point they were expected to present their recommendations to Congress about the appropriate course of action for future Internet tax policy.[106]

The Commission held its first meeting in June, 1999, in Williamsburg, VA, and among the attendees was Federal Trade Commissioner Orson Swindle, who, in his speech, pointed to the many complicated issues that the Advisory Commission would need to address.[107] As

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[105] Most state legislatures were not considering legislation that would make it legal to tax electronic commerce per se, but rather legislation that would require online merchants to collect existing use taxes owed by those customers who lived in a state in which the firm did not have a physical presence.

[106] This entire situation seems like a case of history repeating itself. In 1961, Congress created a special commission to study the issues surrounding sales taxes and mail-order sales. The report, commonly known as the Willis Commission Report, was delivered to Congress in 1965, and made several recommendations including the creation of a multi-state cooperative system that would help ease the compliance burdens of small businesses. Caldwell (1998) provides some history of the Willis Commission and discusses its relevance to the current debate.

[107] Commissioner Swindle was speaking for himself and did not necessarily reflect the views of either the Federal Trade Commission or any other individual Commissioner.

Commissioner Swindle noted, "with approximately 30, 000 taxing jurisdictions, compliance becomes a significant obstacle. The Internet is inherently susceptible to multiple and discriminatory taxation in a way that commerce conducted in more traditional ways is not" (Swindle 1999). These, and other concerns led the Commissioner to believe that coming up with a clear method of defining the Internet tax structure would be "very tricky."

In the months following the first meeting, the Advisory Commission considered various options ranging from no tax, to a flat tax for all electronic commerce. At the same time that the Advisory Commission was considering the possible options, Representatives and Senators, as well as representatives from local governments, began pushing different legislative proposals for dealing with the taxation issue. Wyden and Cox, original co-sponsors of the ITFA introduced legislation that would ask the WTO to enact a permanent global moratorium on taxation of Internet commerce. Similarly, Sen. John McCain (R-AZ) introduced a bill that would permanently extend the ITFA moratorium after its expiration in 2001. On the other side, arguing that local governments stood to lose $11 billion a year, organizations such as the U.S. Conference of Mayors organized panels for lobbying Congress to secure taxation power.[108] Representing this school of thought, Sen. Ernest Hollings (D-SC) introduced a bill that would impose a uniform five percent tax on all remote sales, including Internet and conventional mail-order transactions. In early December, 1999, the Clinton Administration openly criticized a plan proposed by Governor James R. Gilmore III (R-VA) Chairman of the Commission on Electronic Commerce that would have made all online purchases exempt from sales taxes; arguing that such a policy would both disadvantage offline firms and deprive local governments of potential revenues (Chandrasekaran 1999b). Heading into January 2000, it was unclear in which direction the debate would go, and several economic arguments and justifications (discussed below) were being voiced to support the relevant camps.[109]

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[108] Cottman (1999)

[109] For a succinct history of the legal and legislative issues surrounding Internet taxation, see Lukas (1999).

5.2 Current Research on Internet Taxation

The current debate has placed the onus on scholars to provide justifications for why electronic commerce should, or should not, be taxed. A small portion of work has emerged that addresses the equity issues associated with taxing electronic commerce. Much of this scholarship has been theoretical, employing general arguments from traditional public finance economics to support the respective positions. McClure (1999) provides a detailed description of the current debate, comparing it to the history of mail-order catalogues, and argues that electronic commerce should be taxed. Discarding the conventional “infant industry” arguments that might support a moratorium on Internet taxation until the electronic commerce channels are more “mature”, McClure argues that such policies inevitably lead to favored industries “never growing up”. Furthermore, McClure claims that there are substantial horizontal and vertical equity issues at stake, noting that not taxing the Internet is, in effect, providing an indirect transfer of wealth to the rich (who, by and large, engage in electronic commerce more so than the poor).

These sentiments are echoed in earlier work by McLure (1998b), in which he argues that a regime in which the Internet is not subject to taxation will lead to “gross inequities and distortions of economic decisions” and that “local merchants would face unfair competition from out-of-state vendors who pay no sales tax”. The question over whether taxation of electronic commerce is necessary to facilitate a level playing field between the Internet and bricks-and-mortar outlets has been addressed in several sources, including Lukas (1999) and McLure (1998a). In much of this literature, the conclusions have been mixed. Those who favor taxation argue that exemptions for electronic commerce, combined with the current taxation system, will lead to significant distortions that greatly disadvantage conventional retailers. On the other hand, others have argued that the tax differential will merely inspire conventional retailers to migrate to the Internet, and that if state governments are genuinely concerned about equity, they should consider “harmonizing tax rates downward for local retailers” (Lukas 1999, p. 16) rather than creating new taxes for the Internet to eliminate the tax differences.

Moving beyond the theoretical issues associated with taxing the Internet, scholars have begun to empirically examine the possible effects of instituting Internet taxes with respect to sales, and compliance costs. Goolsbee (forthcoming) attempts to determine the price elasticity of demand associated with Internet sales, in order to predict the likely effects on sales and consumption choices that would follow from instituting a tax on electronic commerce. Drawing upon data from a private survey conducted by Forrester Research in late 1997, Goolsbee analyzes the purchasing decisions of 25,000 users as a function of their demographic traits, as well as residential characteristics, including local sales taxation rate. The two questions Goolsbee seeks to answer are a) how does the local sales tax rate affect the choice to purchase something online, and b) how does the local sales tax rate affect the average amount of money spent online by the typical consumer.

In answering the first question, Goolsbee analyzes what drives a shopper to commit to purchasing something online.[110] Controlling for a variety of conventional demographic characteristics such as income, education, and age, Goolsbee finds that the probability of buying something online grows as the local sales tax rate increases. Furthermore, this finding is robust to a variety of specifications, controlling for such features as consumer technological saviness, and general computer access. To determine how offline sales taxes affect the levels of consumers' online expenditures, Goolsbee analyzes individual spending patterns as a function of the local sales tax rate, as well as the usual demographic variables and others aimed at controlling for technological sophistication.[111] In performing such analysis, Goolsbee finds that the coefficient on local tax rate is positive and significant, implying that the higher the local sales tax rate, the greater amount of dollars the average consumer spends online. In summarizing his

[110] Goolsbee conducts probit analysis where the dependent variable is "1" if a surfer purchased something online and "0" otherwise. Independent variables are items such as demographics, rate of computer usage, and local sales tax rate.

[111] Goolsbee conducts tobit analysis where he regresses the total dollar expenditures of those surfers who bought something online onto their respective demographics, local sales tax rates, level of computer literacy, etc.

findings, Goolsbee argues that applying existing tax rates to the Internet will reduce the number of buyers online from 20-25% and reduce total online sales by 25-30%.

Considering his findings, Goolsbee argues against instituting a tax for electronic commerce in the short run for three main reasons. First, drawing on analysis pertaining to the elasticity of demand for conventional mail order sales, he notes that mail order and Internet sales seem equally responsive to taxation.[112] Hence, if taxes are raised on the Internet, it seems likely that consumers might migrate to conventional mail order sales and hence, no sizable revenues will be raised. Second, he notes the complications associated with enforcement; both in identifying what is actually taxable, and actual collection methods. Finally, he argues that there might be positive externalities associated with low/nonexistent tax rates, in that by not taxing electronic commerce now, more consumers will begin to experiment and gain confidence with the medium, which will yield a larger potential tax base should the government choose to institute some taxation scheme in the future.[113]

In light of Goolsbee's findings, questions naturally arise over the robustness of the results given the growth of the web. Quite simply, Internet commerce has exploded since the point in time when the data were collected in 1997, and it is conceivable that Goolsbee's study suffers from a very particular selection bias in that a majority of the consumers in the sample were both more technologically sophisticated and more tax sensitive than the typical offline consumer. In trying to address this question, Goolsbee (1999) revisits the 1997 database, in conjunction with a survey from the following year, also conducted by Forrester Research, and investigates whether these earlier results are robust in the event that the sample becomes more representative of the average consumer. Replicating the analysis from Goolsbee (forthcoming) on the entire sample

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[112] Goolsbee analyzes the propensity of consumers to buy personal computers online, through direct mail, or in stores as a function of local tax rates.

[113] Along these lines, the use of low taxation to facilitate Internet proliferation is somewhat analogous to Rohlfs (1974) and Cabral, et al.'s (1997) results pertaining to penetration pricing in the presence of network externalities. The veracity of this claim is obviously an empirical matter that should be studied further.

of users, Goolsbee finds that the coefficient on local tax rates is still significant and positive, but when one partitions the sample into two groups, experienced and new users, one sees that the tax sensitivities are not very large (or even significant) for new users.[114]

Noting this difference in tax sensitivity between "generations", Goolsbee seeks to determine whether the difference follows from user heterogeneity or education about the tax code. More specifically, one might wonder whether new users simply are not as sensitive to tax rates as old users, or if they simply are not aware of the relevant differences in tax policies between the Internet and bricks-and-mortar outlets, such that it appears that they are less sensitive than experienced surfers. The policy implication from such a distinction, as noted by Goolsbee, is obvious: if these new users flooding the web are relatively insensitive to sales taxes, then arguments against taxation because of high consumer elasticities are moot. If on, the other hand, these new users are simply ignorant about the tax system, and upon learning the system they become tax-sensitive, then the results from Goolsbee (forthcoming) might still be relevant, and hence, implementing taxes on electronic commerce will likely have large chilling effects on electronic commerce. By controlling for demographic similarities across generations, Goolsbee presents results that support the latter argument: consumers, as they become more experienced with the Internet, become more aware of the tax code, and hence more sensitive to local sales taxes in their purchase decisions. Hence, it appears that there is a pervasive, (and sizable), tax sensitivity on the part of consumers, that would negatively affect online commerce, were sales taxes to be instituted.

Putting aside the question over whether taxes on electronic commerce would impede its growth, another question fueling the debate is how much revenue is currently at stake for states to lose? As noted above, the thrust of state governments' arguments is that they stand to lose billions of dollars in tax revenue if appropriate taxation schemes are not implemented to address the Internet. One figure that has been recently cited by the National Governors' Association

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[114] Experienced users are defined as those who have been connected to the Internet for at least two years, while new users are those consumers that have been connected for less than two years.

(NGA) puts the potential revenue loss following from Internet and mail order sales at $20 billion a year by 2002 (Associated Press 1998). If such figures are accurate, then it is hardly surprising that local governments are pressing the case for taxation so aggressively--with such large quantities of funds at stake, local infrastructure might be impaired if appropriate legislation is not implemented. The important phrase in the above sentence, however, is "if". Crucial to the argument of the states and local municipalities is that the Internet, is indeed, likely to take such a sizable portion of their revenues out of their grasp.

In trying to assert the validity of local governments' claim, Goolsbee and Zittrain (1999) conduct an exercise in revenue deconstruction to determine where states' revenues are currently coming from, and how the Internet is likely to affect them. Contrary to popular beliefs, the authors conclude that the Internet will not wreak financial havoc on local finances in the foreseeable future, and hence, argue that tax-imposing legislation is neither a necessary nor appropriate manner with which to deal with the concerns voiced by the government agencies. To give a brief summary of their findings, the authors begin by arguing that the figure cited by the NGA is inappropriate for three main reasons. First, it includes business-to-business commerce, which is currently exempt from sales tax, regardless of the method of transaction. Second, the estimate ignores the possibility of trade creation following from the Internet that might be generating much of the commerce observed. In other words, some of these potential revenues would not even exist in the first place if it was not for the Internet, and hence, it is inappropriate to view them as "lost" revenues. Finally, even if the NGA is focusing on valid taxable items, their treatment of such items artificially inflates the potential loss.[115]

After stripping away those categories of goods that are either already being taxed, or not subject to sales taxes, Goolsbee and Zittrain claim that only $2.5 billion of sales are subject to taxes which are not being collected--which totals to a tax revenue loss somewhere between $210-

[115] For example, the NGA counts the online sale of home computers as revenue losers even though most online computer sellers collect/pay sales taxes in some capacity.

430 million in 1998.[116] Contingent on a high rate of growth in electronic commerce, the authors note that projected tax losses in 2002 will come to somewhere around $2.5 billion, and $3.5 billion in 2003, which is less than two percent of potential sales tax revenue--a far smaller figure than that being cited by the NGA. Contending that conventional arguments about the need for taxes to “level the playing field” or ameliorate distributional concerns are unfounded, the authors push for a moratorium on Internet taxes so that usage might proliferate across all demographic groups and the maximum benefits of the network might be realized.

Closely related to Goolsbee and Zittrain’s study, Cline and Neubig (1999b) perform a similar revenue decomposition exercise on sales data from 1998 to determine how much governments plausibly stand to lose to the Internet, absent new taxation legislation. After discarding those categories of goods that cannot be considered as revenue losers, Cline and Neubig determine that the total amount of untaxed sales in 1998 was somewhere near $2.6 billion--a figure very close to that determined by Goolsbee and Zittrain. From this estimate, the authors argue that the actual revenue loss to the Internet came to only $170 million in 1998. Given that current tax losses only amount to about 0.1% of total revenues, the authors claim that the notion of a tax “crisis” is inappropriate and that state and federal governments have plenty of time with which to develop an efficient and useful taxation scheme (if any) that can be applied to electronic commerce.

Besides the effects on consumers and the relevant revenue streams at stake, another concern that has been voiced is the possible compliance costs associated with instituting different tax policies. Sales taxes of various forms are currently imposed by 46 states and almost 7,500 local governments in the United States. These taxes are not typically uniform across all goods, but rather applied to certain distinct commodities, depending upon the jurisdiction in question. Absent some sort of technological intervention, requiring online merchants to determine what is

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[116] The authors note that this $2.5 billion figure can only be accepted if one makes the assumption that somehow taxes would be collected on all auction transactions as if they were sales made through classified ads. The estimated size of the total tax loss is subject to variations in predicted growth in electronic commerce by the end of 1998.

taxable and the appropriate rate for a given destination as well as ensuring collection, might place significant burdens on retailers. (This is implicitly the rationale behind the court decisions in the landmark mail-order cases). While it is difficult to offer a comprehensive picture of the relative compliance costs involved, a recent study by the Washington State Department of Revenue (1998) offers a vision of what kind of burden imposing current local taxes on all online sales might impose.

In fulfilling the statutory requirements of the 1998 Washington State supplemental budget law, the Washington State Department of Revenue distributed a survey to 3,400 retailers in Washington and Oregon to determine the costs incurred by retailers in complying with collecting and remitting state and local sales taxes. From a response rate of 51% for Washington retailers and 36% for Oregon retailers, the Department of Revenue's study states that the total cost to retailers for collecting and remitting sales taxes are 4.23% of total state and local taxes collected. Furthermore, it is observed that the burdens associated with tax collection and processing are not uniform across all businesses. When considering variations in retailer size, the study finds that costs range from 0.97% for large retailers to 6.47% to small retailers. Hence, in order to collect and remit sales taxes in their own state, small retailers are spending about $6.50 of every $100 collected on determining the relevant tax rates and exemptions for the goods being sold. It seems reasonable that these costs would be higher if merchants were required to collect taxes from states in which they do not have a presence and intimate knowledge of the tax code.[117]

5.3 Summary and Implications

In summary, on the question of Internet taxation, most scholars and public officials have embraced one of two lines of thought. Those in favor of mandating new sales taxes for the Web point to the lost revenues to state and local governments that will likely occur without such taxes.

[117] Cline and Neubig (1999a) provide a succinct discussion of the findings of the Washington State Department of Revenue study as well as a brief picture of the complexities that surround the sales tax code in various municipalities across the country.

Furthermore, there are arguments to be made about the desire to maintain an economically neutral sales tax system, which might dictate the adoption of Internet taxes. Those opposed to Internet taxes claim that first, the relevant levels of revenue at stake are not particularly large, and that implementing taxes on the Web will only serve to chill online purchases, and electronic commerce more generally. Those opposed to taxes also point to the potentially large compliance costs for retailers that will follow from collecting and remitting such taxes. While this latter point may be solved though technological, or other means, no obvious solution is currently available.

While the current body of work dealing with Internet taxation is not amazingly broad, it is impressive in that it makes effective use of what limited data are available. With the rate at which the Internet is growing, it is quite difficult to acquire useful data and perform analysis such that the conclusions will still have substantive bite by the time the article in question has weaved its way through the referee process. That being said, the work discussed above is admirable in that it successfully provides, at the very least, a first-order approximation of the relative effects associated with mandating taxes on Internet sales.

As electronic commerce continues to grow, there are several issues that will need to be investigated thoroughly in order to determine appropriate tax policy. Chief among these issues are those that have been discussed above: the magnitude of the revenues forgone by local governments absent Internet taxes, as well as the likely effects on purchases that will follow from introducing such taxes. Conventional public finance scholarship such as Mikesell (1970), and Walsh and Jones (1988), have shown that differential sales tax rates can lead to the migration of commercial transactions towards jurisdictions that most favor consumers. While the studies discussed above would seem to support this conclusion, further data analysis will serve to confirm whether the magnitudes associated with these findings are robust, or merely the symptoms of preliminary shocks to the system that are being exhibited by an “infant” industry.

Another issue that will need to be addressed is the actual harm to bricks-and-mortar businesses from competing with outlets whose goods are not subject to sales tax. As noted above, theory would argue that taxing identical goods at different rates would likely lead to consumers shifting their purchases towards the lower-taxing outlets. While such a shift can (de facto) be pro-competitive if the less-expensive outlets are able to provide lower prices due to economies of scale, if the price differential is solely a function of the lack of sales tax, then such consumption shifts are inefficient.[118] As noted by Goolsbee and Zittrain (1999), one would ideally like to have access to panel data which details consumers' retail buying habits in both bricks-and-mortar outlets and online over time to see if consumers are shifting their purchases as hypothesized. Unfortunately, as noted by the authors, no such data currently exist. Future research might aim at filling this obvious gap in the literature by conducting such a study, which will help determine whether the theoretical inefficiencies that follow from differential tax rates are being empirically realized on the Internet.[119]

A final issue, the matter of compliance costs, will likely be dealt with through either legislation or technology so that they are not excessively cumbersome. Besides the possibility of some sort of uniform tax on all Internet sales, there are currently several software companies that are devising programs that allow retailers to instantly calculate the relevant sales taxes for purchases made in remote locations. While the costs of these packages may be currently too high for widespread use among small retailers, (Lukas (1999) quotes a price of $20,000) it seems reasonable that the costs associated with such technology will become more manageable in

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[118] In addressing the subject of tax evasion, Trandel (1992) argues that differential tax rates, while possibly welfare-reducing with respect to aggregate state revenues and consumer purchase decisions, might also enhance welfare, in that the tax evasion that follows might serve to drive product prices towards marginal costs. Hence, the overall efficiency effects of differential tax rates and potential evasion seem ambiguous.

[119] A closely related subject to this debate is the question about what strategies brick-and-mortar firms might employ to retain customers and reduce the ability of online firms to free-ride on them with respect to product display, showroom expertise, etc. Given that it is simple for customers to wander around a real-world store examining products, and then purchase them on the Web for a lower price (and to avoid taxes), one might wonder whether such a trend will lead to an inefficient reduction in offline stores; and what measures brick-and-mortar stores can take to avoid such migration to the Web. There is room for significant theoretical and empirical research in this area.

response to the increased demand that would come with mandated taxes.[120] Hence, one way or another, it seems that compliance costs are destined to fall to levels that might facilitate the implementation of taxation schemes to be implemented. Therefore, in predicting how electronic commerce is taxed (if at all), it seems the debate will turn on one of the first three issues: consumers' price elasticities of demand with respect to Internet sales, the potential effects of "forgone revenues" on local communities, and the threats to "main-street businesses" and bricks-and-mortar outlets posed by e-commerce. All three of these matters are very politically charged, and will likely lead to very interesting developments on Capitol Hill within the next few years.[121]

Section 6: Conclusion

No one can deny that the Internet has had a noticeable effect on society in general, and popular perceptions of the economy in particular. While originally developed as a tool for academia and government, the Internet has expanded in scope to become accessible to (and incorporated into the daily lives of) representatives from virtually all demographic groups. Faced with the possibilities of quick wealth in electronic commerce, entrepreneurs have begun experimenting with wildly diverse business models, ranging from conventional sales transactions to unorthodox practices such as providing free content and products in the hopes of securing a sizable market share. While many might remain skeptical about the viability of certain business

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[120] In the area of software provision, innovative and unconventional methods are currently being devised to deal with the burden of tax determination. One option derives from a recent invention by two accountants from New Jersey (Chartrand 1999); it would transfer taxes directly from consumer to governments, using the credit card companies as an intermediary. Taking the collection and remittance responsibilities out of retailers' hands, would, in theory, greatly ease the complications associated with applying sales taxes to online commerce. As of early 2000, several companies had announced their intention to release sales-tax accounting software packages that could calculate sales taxes across 60,000 potential tax jurisdictions (Jones 2000).

[121] Some of these issues have been raised more immediately at the state level. In February 2000, two bills were introduced into the Virginia legislature aimed at abolishing Virginia's 4.5% sales tax. Those in favor of the legislation felt that it was an appropriate way to level the playing field between traditional merchants and online firms; and argued that the lost revenues from sales tax would be more than recouped from the boom in the state's income tax revenue (Timberg 2000).

practices, or uncertain about the likely evolution of the Internet, most can agree that substantial change is likely in the future.

This essay has examined economic perspectives on various issues pertaining to Internet development. Sections 1 and 2 discussed some of the technological aspects of the Internet and presented several theoretical models that have been conceived to address different ways to price Internet access. Section 3 focused on theoretical and empirical studies that relate to electronic commerce, on matters such as the possible effects of changes in consumer search costs on firms' pricing policies, as well as methods that might be employed by firms to separate consumers and engage in price discrimination. Section 4 addressed the role that network externalities might have on Internet development and the strategies employed by firms engaging in electronic commerce, drawing on the theoretical results from traditional economic literature, as well as more recent work. Finally, Section 5 focused on the arguments for and against taxation of Internet commerce, addressing the relevant academic (and political) perspectives.

While this work is a solid first step towards investigating the economics surrounding this new transactions medium, there is still much work to be done. There are several important subjects that have not been addressed in this essay, such as the effects of the Internet with respect to intellectual property, and the economics of personal privacy and information sharing. In addition, there is significant room for large-sample empirical research to be conducted that might investigate whether the theoretical implications of the models discussed (with respect to market structure, pricing policies, network architecture, etc.), hold true in the context of the Internet.

To review some of the suggestions considered, on the question of access provision, scholars might seek to examine, through simulations or experimental settings, which of the proposed models of access pricing seem to perform better, from an efficiency standpoint, under different circumstances. On matters pertaining to electronic commerce, there are several interesting questions that will become possible to answer as the electronic marketplace matures and more data become available. Inquiries about the magnitude and significance of differences between online and offline prices, the potential for online collusion, and the effectiveness of the

Internet and electronic markets as a clearinghouse for second-hand goods pose topics that can serve to increase our understanding about the potential for the Internet to facilitate a world of "frictionless commerce." Scholars investigating network externalities might seek to refine earlier studies such that they can offer guidance for distinguishing between market power that arises from normal competitive responses and market power that arises from anticompetitive exploitation of network externalities. Finally, in studying Internet taxation, scholars might seek to investigate whether current findings pertaining to consumers' online purchasing patterns as well as likely revenue streams for local governments are representative of a long-run stable outcome, or more reflective of a shock to the system associated with an "infant industry".

Regardless of what direction is taken, this essay will hopefully serve as a useful roadmap of relevant research pertaining to some economic aspects of the Internet and a solid starting point from which to begin future inquiry. As the Internet becomes relevant to more sectors of our economy, we should expect to witness numerous changes that can significantly enhance consumer welfare. Further scholarship can only serve to enhance our understanding of this new and exciting transactions medium, as well as (hopefully) establishing some well-accepted principles that might help to guide government antitrust authorities in the regulatory process, and to assist their efforts in maintaining viable competition.

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