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Information Inequality and Network Externalities:
A Comparative Study of the Diffusion of Television and the Internet

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The term "network" has become a dominant trope in studies of contemporary capitalism, used to explain what distinguishes advanced capitalism from its industrial predecessors (DiMaggio 2002). Capitalist workplaces are alleged to be more egalitarian with more lateral and fewer hierarchical ties than their more bureaucratic ancestors. Companies are said to collaborate to a greater degree, their ties characterized more by the fluidity and give-and-take of social relationships than by the fixity and formality of arms-length contractual agreements. Consumers purchase goods as much for their ego-congruence as for their instrumental utility, bolstering identities negotiated in social interaction rather than through fixed and formal statuses. The global economy itself is portrayed as a vast network of exchanges that crisscross national boundaries, leaving states powerless to control them. It is clear that students of capitalism have found networks "good to think with," in Mary Douglas's phrase (1979: 40), a powerful metaphor for capturing the fluidity and reach of economic relations. Indeed, the most ambitious effort to characterize contemporary capitalism, Manuel Castells (1996) characterizes the dominant contemporary social formation as "the network society."

In this paper, we focus on two more concrete and specific ways in which networks figure into the practice and study of contemporary capitalism. The first is as concrete technology. Communications networks are the vehicles through which information flows, and for the past century, information and the services used to communicate it have

become ever larger components of capitalist production and distribution, roughly doub-

ling (with nontrivial disagreements resting on definitional issues) in the advanced econ-

omies during the last half of the 20th century (Machlup 1962; Porat 1977; Rubin and

Huber 1986; Castells 1996). Global telecommunications networks did not *cause* the

changes in capitalist workplaces noted above, but they clearly facilitated them (Castells

2001). Mobile telecommunications increase both the ease with which employees can

share information and solve problems across departmental lines and the costs to firms

that insist on maintaining hierarchical lines of communication. New kinds of manage-

ment information systems permit firms to coordinate their activities in real time by mak-

ing data on production schedules and inventories immediately accessible to both partners.

The Internet places an immense range of products within the grasp of anyone with suffic-

ient income, facilitating new levels of stylistic differentiation and enabling middle-class

consumers to reinvent themselves with props from around the world. And global

communications networks undergird the transborder flows of money and data upon

which the world economy has come to depend. In this sense, then, "network" as trope

rests on "network" as literal technology.

Second, we employ "network" as a theoretical construct, drawing on economic

theories of "network goods" and services. Network goods and services are those that ex-

hibit "network externalities": that is, their value to adopters increases as a function of the

number of other people who use them. Such technologies have increased in number and

importance over the past century, as people's consumption decisions and opportunities

have become more interdependent. We draw on the work of economists to understand

patterns of technology diffusion, and expand upon it by suggesting that the concept

should be understood more broadly to include social, as well as individually instrumental, utilities.

Our interest in these topics was stimulated by the senior author's research on inequality in access to and use of the Internet in the United States, and therefore we focus on that technology in much of this paper. Once one documents inequality in access to a relatively new technology, it becomes imperative to understand the trajectory along which that technology is diffusing. Without a model of the diffusion process, one has no way of knowing whether a given level of inequality represents a long-term policy challenge or a temporary inconvenience. Thinking about the Internet leads one to ask what general factors account for group-specific patterns of technology adoption. This line of questioning that led us both to the notion of "network externalities" *and* to the exploratory analysis, comparing of the early diffusion trajectories of television and the Internet, with which we conclude this paper.

We have three goals for this paper. First, we want to bring the economic construct of network externalities into sociological analysis of technological inequality, while at the same time inflecting it sociologically. Second, we will sketch a comparative model explaining variation in the diffusion patterns of different communications technologies, in order to place the Internet case in a broader theoretical and empirical context. Third, we present findings from a comparative analysis of household adoption of television from 1948 to 1957 and the Internet from 1994 to 2002 that cast light on the extent to which intergroup inequality in Internet access is likely to persist as the diffusion process continues.

Social Inequality and Internet Access, 1994-2003

Social scientists recognize that information plays a crucial role in processes that generate social inequality. Measures of "aptitude" or "achievement" (which serve as proxies for generalized information or for the capacity to acquire information) are staples of work in educational attainment. Studies of the impact of networks on career advancement (Granovetter 1974; Burt 1992) and consumer purchases (DiMaggio and Louch 1996) emphasize the role that interpersonal relationships play in the acquisition of market information. It stands to reason that if information is important, then command of technologies that provide access to information or facilitate communication (telephones, fax machines, television sets, computer modems) must help people get ahead. Yet with few exceptions (Attewell 2001; Autor, Katz and Krueger 1998), neither sociologists nor economists have studied systematically the relationship between life chances, on the one hand, and access to information technology and the ability to use it, on the other.

The Internet, which occupied such a large space in America's consciousness during the technology boom of the 1990s, began to change this situation. By appearing to reduce the marginal cost of information and communications nearly to zero, the Internet and World Wide Web inspired extravagant claims that a new age of information equality was dawning. Now everyone, the Web's advocates claimed, could have access to the best information about health, the means to participate fully in the polity, wide-ranging information about job opportunities, and other advantages formerly restricted to the well to do or well educated. Because people can benefit from the Internet's offerings only if they can go on-line, it was natural for policy makers to worry about, and social scientists

to study, the "digital divide," as inequality in access to this new technology came to be called.

The basic dimensions of the digital divide are well known (DiMaggio et al. 2004). In the United States, having a college education, a high income, "white" racial identification, and youth all raise the odds of having Internet access. In 2001, among Americans aged 18 or older, just 26 percent of African-Americans compared to 47 percent of everyone else could go on-line from home. So could more than two of three college graduates, but just 43 percent of high school graduates who had not gone on to college. Americans with family incomes greater than $67,500 were twice as likely to live in homes with Internet service as those with incomes from $20,000 to $30,0000; and people aged eighteen to twenty-five were twice as likely to have such service as persons older than fifty-five (DiMaggio et al. 2004, Table 1).

Policy analysts and communications experts agree that these differences exist but quarrel over what they mean. The problem is this: At any point in a diffusion process, intergroup inequalities reflect distinctive diffusion processes for particular population subgroups. If groups are traveling along the same path, but have started at different points and are proceeding at different speeds, different adoption rates simply reflect the shape of the diffusion curve and the groups' relative progress toward a common destination. If their trajectories are radically different, disadvantages may persist indefinitely.

Most diffusion processes are roughly S-shaped, with a long and gradual build-up period followed by a rapid ascent after which growth levels off. For technologies that are eventually adopted universally (or nearly so), absolute differences in penetration rates between more and less advantaged groups tend to be modest during the build-up phase,

spiral upward during early takeoff phase, and diminish rapidly once the less advantaged group has also entered take-off and the rate of increase of the more advantaged group has slowed. The global diffusion rate for a given society, of course, represents the aggregate of these different group-specific trajectories.

Between 1994 and 2001 (the last year of Current Population Survey data available to us), different intergroup disparities followed differing paths. Gender inequality in Internet access, significant in the mid-1990s, largely disappeared; and place of residence likewise became less important. By contrast, inequality in access on the basis of race, educational attainment, and income remained substantial (DiMaggio et al. 2004).

There are many reasons for the persistence of intergroup differences, not the least of which is their mutually reinforcing character due to correlations among education, income and race. The underlying process generating these differences is one of individual choice under institutional constraint. Institutional factors loom large because of unequal access to schools and jobs that provide access to and training in new technologies, unequal investments in neighborhood libraries or community technology centers, and unequal access to high-speed Internet service based on place of residence. Many, although not all, of these institutional factors tend to raise the effective cost of Internet access (in time or money) to precisely those people – low-income persons with relatively little education – who have fewer resources to invest in information technology in the first place. Individual choice is also crucial, especially for household Internet service, because, except in those rare cases where a resident's employer provides it, at least one household member must invest in a service contract.

Individual choices to invest in communications technologies and related goods and services are systematically different than choices to purchase many other kinds of goods and services. Most goods are "rival": If I consume them there will be fewer left for you. Consumption of many other services is competitive: purchasing more or better education offers advantages to me only if you decline to do the same. By contrast, communications technologies tend to have what economists refer to as "network properties," whereby my purchase of a good or service may *increase* its value to you. Indeed, one can argue that an important feature of contemporary capitalism is the increasing economic and social prevalence and importance of goods and services with "network externalities" relative to earlier market economies. In order to understand the factors influencing inequality in access to the Internet, then, it is necessary to understand a little about goods and services of this kind.

Network Externalities, Technical and Social

A product or service possesses network externalities if the utility one derives from it is a positive function of the number of other people who consume it.[1] For example, a telephone is of little value if no one else is using it; of moderate value if only a few of one's potential contacts use it; and indispensable if everyone uses it. Most communications technologies are network goods in this sense: They literally constitute a network, and the value of the network depends on the number of persons (or organizations or other entities) connected to it (Shy 2000; Varian 1999).

Earlier communications technologies typically came in the form of goods (newspapers, books, magazines) or services (performing-arts events, the conveyance of telegraph messages). By contrast, modern communications technologies typically combine

a product (a radio, a telephone, fax machine, television set, computer, or piece of soft-

ware) *and* a service (broadcast programming, telephone service, fax transmission, or

Internet access). Also typically, the real money is in selling the service (which produces

an ongoing revenue stream) rather than the product (which is usually a one-shot purch-

ase); and the value of the service derives from the number of persons on-line, which is to

say the positive network externalities. Often these externalities are *direct*: The value of

e-mail to me depends on how many of my friends I can reach through it. The value of

Kazaa to its users depends on how many other users make their own MP3 collections ac-

cessible through it.   The more people participate in E-Bay auctions, the more attractive

the merchandise and the more spirited the bidding. Positive network externalities may

also be *indirect*, i.e. based on role complementarity.   The more people who watch a net-

work television program; the more advertisers will compete to buy commercial time on

it; the more people who put Acrobat Reader on their computer, the more likely are people

who want to share documents to buy the full software package; the more consumers join

Pay Pal, the more merchants will give Pay Pal a cut of their revenue for mediating trans-

actions. Such complementary network externalities often redound to the benefit of non-

paying consumers (in the form, for example, of more lavishly produced television shows,

more accessible manuscripts, or easier on-line shopping).

This feature of information technologies (that they simultaneously comprise pro-

ducts and services, and that these services entail significant network externalities) pro-

duces a distinctive form of business strategy: subsidization of some forms of consumpt-

ion in order to build networks large enough to sustain particularly profitable revenue

streams. Thus IBM shared its operating system with software makers in the 1980s, tele-

phone companies practically give away cell phones to new subscribers, and you can download Netscape or Acrobat Reader software for free. (Where producers are unable to charge continuing fees for services, they may take the opposite approach. Thus in the 1920s, producers of radio equipment subsidized radio programming in order to sell more radio sets [Douglas 1987: 299-300].)

Social Network Externalities

So far we have been talking about material or market externalities, where the rewards to network expansion are of tangible utility to consumers, service providers, and/or advertisers. From a sociological perspective, there are other, equally important, forms of network externalities, both negative and positive, which may also play a role in the diffusion of new technologies. We define an externality as *social* when the size or composition of the market for a good or service influences the value of consumption of that good or service *as an input into an individual production function, the output of which is social identity*. We discuss briefly three simple and familiar kinds of social network externality.

(1) Societal membership as a network externality. People need certain goods or services to be full-fledged members of their community (Rainwater 1974). Within any community, there are reasonably well-established expectations about what *bona fide* members owe one another in terms of both availability and knowledgability. The spread of communications and information technologies extended the scope and changed the nature of such claims. With respect to availability, Americans, for example, are expected to be reachable by telephone. Individuals without telephone service occupy a kind of social and labor-market limbo. (Within the academic community, failure to use e-mail

came to be perceived as a lamentable abdication of citizenship obligations at some point during the early 1990s.)

With respect to information, the emergence of mass communications placed a premium on certain kinds of baseline knowledge, which became the stuff of everyday conversation. In the contemporary United States, knowledge of this kind is occasionally political --- Americans expect one another to have opinions about presidential candidates, and to be able to identify such figures as Arnold Schwarzenegger and Osama Bin Ladin. More often, however, such information concerns popular forms of entertainment like "The Simpsons," "Seinfeld," "South Park" or "Sesame Street." As Horace Newcomb and Paul Hirsch (1983) and W. Russell Neuman (1991) have noted, television has played a key role as a source of such socially expected information since the 1950s, a role to which it was well-suited during the network era but which the proliferation of cable channels and satellite services has undermined. Goods and services that provide such socially expected information are an integral medium through which groups convey basic elements of their shared construction of reality, making connectivity essential if one wants to participate in communal discussion and comprehension of the world.

Information and communications technologies that are sources of socially mandated forms of availability and knowledgability become effectively indispensable. To achieve such social indispensability, technologies must have two properties. First, they must be reasonably attractive and effective. (The advantages of telephone communication became quickly apparent, although economic factors slowed its spread; and television beguiled audiences from the start.) Second, they must be economically affordable (either because they require one-shot purchases like television sets, or because minimal service

is kept relatively cheap as a matter of public policy, as is the case for telephone and basic

cable service in the United States).   If these conditions are present, social-membership

externalities eventually reach a tipping point at which only the very poor or very eccent-

ric will do without them.   Indeed, near universal diffusion is probably only achieved by

technologies for which such social-membership externalities are present.

Status-group affiliation as a network externality. By "status group," I refer to a

social group united by a shared sense of identity, common status culture, and practices

that produce internal cohesion and clear boundaries. Certain forms of communication

and information technologies are useful in the production of group identities, with their

utility increasing with the proportion of group members employing the technology.

(Goods with this type of externality are similar to what economists have called "club"

goods.) In some cases, as when Islamic militants in pre-revolutionary Iran used sound

cassettes as a means of spreading their beliefs because other media were closed to them

(Manuel 1993), a technology is put to practical use. This is also the case for virtual

groups (for example, isolated persons with low-incidence medical conditions or political

extremists with low-incidence ideologies) that the Internet has brought together and given

voice. In other cases, consumption may be more strictly symbolic (e.g., the ubiquitous

use of transistor radios by U.S. teenagers in the 1960s, of pagers by their urban counter-

parts in the 1980s, or of Internet-equipped cellular devices among contemporary Japanese

adolescents).

Prestige and negative externalities. Since Veblen (1899), economists have noted

that consumers pursue certain goods because they bestow social distinction upon their

possessors. For such consumers of such goods, the diffusion of a technology or product

to additional strata represents a negative externality because it reduces the prestige value of consumption. This can occur when the price falls, when the technology becomes simpler, or when producers alter the contents to make it more appealing to a mass audience. Negative externalities are relatively rare in information and communications technologies, although they can be discerned in the negative response of some techies to the commercialization of the Internet or to the rise of mass portals like AOL; in cases in which original participants in interactive spaces withdraw when the number of less committed or less sophisticated users multiplies; or, as we shall see, in the aversion of college graduates to television during the 1950s. Other things equal, prestige hierarchies moderate the slope of adoption curves, as early adopters flee in the face of new entrants.

Note that we use the term "network good" more broadly and loosely than do economists, who restrict it to what we refer to in Figure 1 as "pure network goods." We broaden the term in three ways. First, we identify "social" as well as "instrumental" externalities, and suggest that the former may be as important as the latter. Second, we regard the extent to which a good or service possesses network externalities as a continuous variable, rather than viewing network goods and other goods as clearly separable classes. Third, we identify two analytically independent dimensions of "networkness" (the degree to which goods' use entails social interaction and the extent to which users care about the specific identities of other consumers).[2]

Network Externalities, Social Networks and Technology Diffusion

Think of diffusion curves as the precipitate of millions of individual choices. Such choice processes can be modeled in the following way (Granovetter and Soong 1983). Each potential adopter places a value on the technology, such that she or he will purchase

it when its cost falls to her or his reservation price. Where reservation prices are normally distributed and scale economies apply, we get the familiar S-curve. Each new wave of adoption reduces the cost a little bit, so that it reaches the level at which new consumers will sign on. (Because reservation prices are normally distributed it does this at an increasing rate, generating a slow uptake followed by a rapid ascent.) Where reservation prices are clumpy or scale economies weak, the process may be arrested early on, so that only a small proportion of the potential market ever adopts.

We expect network externalities to generate the S-curve in a similar, but exaggerated way, due to the interaction of two mutually reinforcing processes. First, prices decline due to economies of scale. Second, at the same time, the *value* that potential consumers place on the good -- and therefore their reservation prices – rises at the same time, as more people adopt. This combination of scale-economy dynamics and ascending reservation prices can yield explosive patterns of growth, similar to the increase in Internet usage in the U.S. between 1995 and 2000.

Not all network externalities have the same implications for diffusion processes, however. Although all network externalities lead users to benefit as a function of the overall size of the user population, they vary along two key, correlated dimensions (see Figure 1): First, to what extent does use of the technology entail direct interaction with other users? Second, to what extent do users care who else is using the technology? The two are correlated: In general, we care about the identities of technology users more if we use the technology to interact with them. We sign on to an instant messaging service not because lots of other people do but because *our friends or family members* use it. We download Adobe Acrobat Reader because we believe that the particular people who use
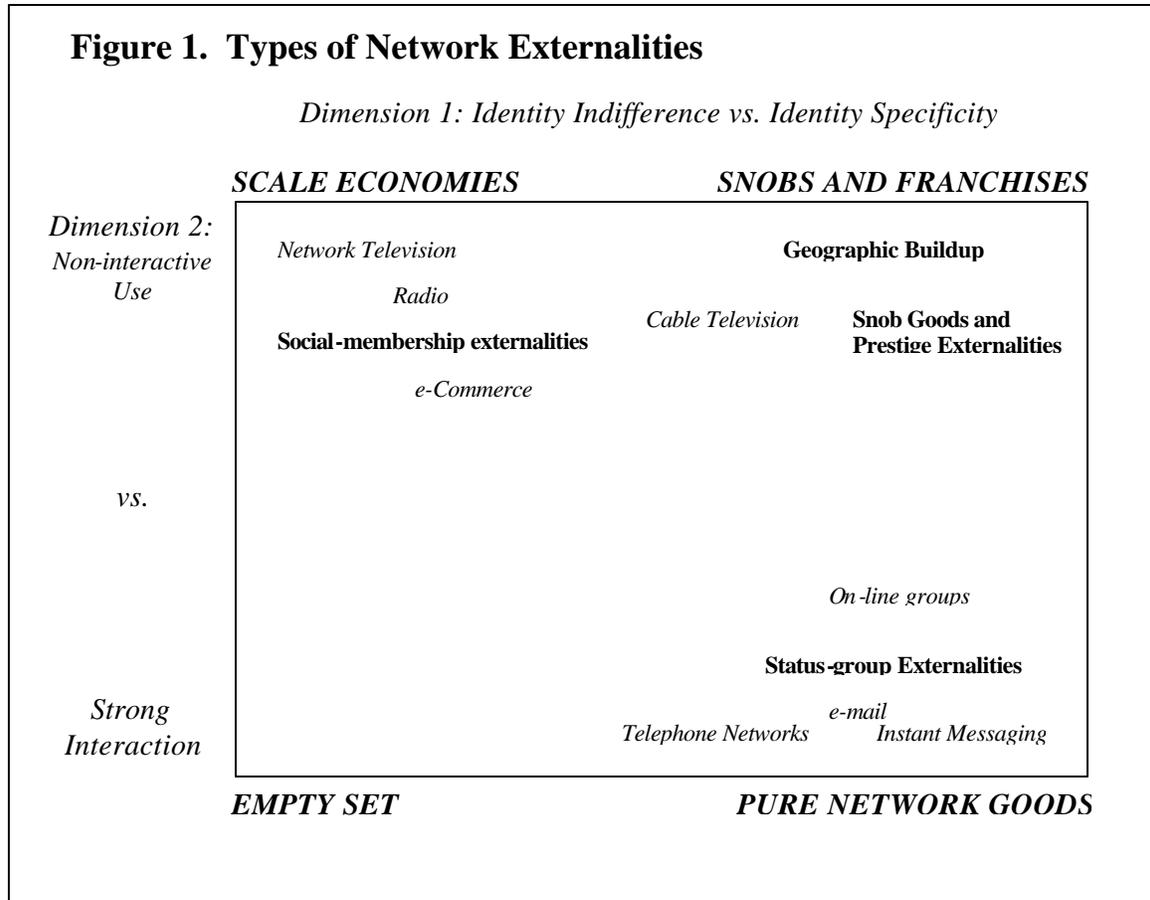
Acrobat Writer will produce *.pdf* files that we will want to read.   In these cases, adoption

by many users raises our reservation price only slightly, but adoption by a few particular

users may increase it significantly.   So network externalities are strongest, and the dyn-

amics associated with them particularly intense, in the bottom right region of the Figure

1, where both identity specificity and intensity of interaction are high.

When we neither care about the identities of other technology users nor interact

with them, network externalities are weak --- so weak that economists do not even con-

sider such technologies to be network goods. Rather, they use the term "scale econom-

ies" to refer to benefits conferred upon producers by third parties (for example, vendors

who reduce prices, or advertisers who pay more for airtime), some fraction of which are

passed on to consumers in the form of lower prices or higher quality (in response to

which potential adopters may raise their reservation prices).

The correlation is not perfect, however. The mass media have social-member-

ship externalities that enable us to refer to media content in interaction with many other

people. But we do not care (or at least not very much) *who* else is watching Seinfeld re-

runs, the Emmy Awards show, or the Olympics.   Rather we value the fact that we can

make conversation about such media content with almost anyone we happen to meet.

On the other hand, people who use commodities for status display may care deep-

ly that the right kind of people have adopted a given product (e.g., a Movado watch or an

expensive brand of Scotch) even though it is only rarely a focus of interaction. Technol-

ogies like cable television that require local infrastructure also inhabit the upper right

quadrant, but for a quite different reason: because of physical constraints, distribution

markets are localized, and other people's adoption will only enhance the availability and

quality of my service if those other adopters occupy the same service area as I do.

Figure 1. Types of Network Externalities

Dimension 1: Identity Indifference vs. Identity Specificity

	SCALE ECONOMIES	*SNOBS AND FRANCHISES*
Dimension 2: Non-interactive Use	*Network Television* *Radio* **Social-membership externalities** *e-Commerce*	**Geographic Buildup** *Cable Television* **Snob Goods and Prestige Externalities**
vs.		
		On-line groups **Status-group Externalities** *e-mail*
Strong Interaction		*Telephone Networks* *Instant Messaging*
EMPTY SET		*PURE NETWORK GOODS*

Why network externalities make a difference to technology adoption. Network

externalities are important for technology diffusion because they make adoption decisions

interdependent.   This in turn means that the structure of social networks – in particular,

density, homophily, and the location and availability of "bridges" connecting networks

comprising people of different kinds (Rogers 2003: 306; Watt 1999) -- will have import-

ant implications for adoption rates in general, and for intergroup inequalities in particular.

Network structures interact with the types of externalities illustrated in Figure 1.   Each

location in Figure 1 mandates a characteristic pattern of diffusion, other things equal.

The further to the right on the *x* axis (identity specificity), the more adoption will be bound by the contours of social networks, and tend to occur one network region at a time. (This is because my reservation price becomes lower not when *anyone* adopts, but only when someone in my own social circle comes on board.) The further to the left on the *x* axis, the more adoption will be driven by individual convenience and exposure to marketing. The *y* axis refers primarily to the rate at which adoption information circulates – quickly at the bottom, where the technology is a focus of interaction, more slowly at the top --- and therefore largely influences the rate at which the process proceeds.

True network goods – that is, those that are high in interactivity and identity specificity – are likely to have distinctive growth profiles, based on the island-like quality of group-specific diffusion processes (where "group" refers to a relatively highly bounded social network). Adoption proceeds slowly within each network region until reaching a tipping point after which network members find the new technology indispensable. Depending upon the number and shape of bridges across network regions, adoption will cascade from one network region to another, as "bridges" (persons connected to others in each network area) act as seeds for new adoption processes.

What does this have to do with intergroup inequality in access to the Internet? First, the Internet is a network service par excellence – or rather it is a technology that includes a range of network services (e-mail, instant messaging, interactive discussion groups, file-sharing software), in addition to some services with weaker network externalities (e.g. on-line shopping, downloading IRS forms). It seems likely that most adoption to this point has been driven more by the former than by the latter.

Second, due to *social homophily* (the tendency of people to interact most heavily with people like themselves) the network regions in which adoption gestates and across which diffusion cascades are often characterized by substantial homogeneity with respect to such things as educational attainment, income, and race.   Although a formal development of these ideas is beyond this chapter's scope, intuitively it seems likely that, *ceteris paribus*, the rate at which initially disadvantaged groups catch up with initially advantaged groups will depend not simply on the economic resources they command, but also on the homogeneity of the social networks in which they participate.   Where social isolation of outgroups is high, members of initially low-adopting social categories may have little reason to adopt a network technology.   Where interaction across categorical boundaries is high, one would expect intergroup disparities to be only temporary.   The fact that differences in Internet access related to race and educational attainment, for example, have shown little sign of abating is consistent with research demonstrating high levels of network homophily with respect to these very characteristics (Marsden 1987).

Towards a Comparative Model of Technology Diffusion

The strength and nature of network externalities is only one of the factors that influence patterns of technology diffusion and the extent and tenacity of intergroup inequality in adoption.   In this section we take an inventory of consequential conditions.

One set of influences is technological.   Diffusion rates are shaped by the development and location of infrastructure necessary to sustain individual or household use (e.g., local broadcasters for television, broadband connections for streaming video).   In the early years of television, the major constraint on adoption was whether one lived close enough to a broadcast station to receive the signal.   In the early years of high-speed

Internet service, major constraints have included the distance of one's home from one's ISP and the age of the local cable system (for DSL and cable, respectively).

Purely economic influences also come into play. Cost significantly constrains adoption, especially early in the diffusion process before significant scale economies have been achieved. Equally important is the distinction between one-time purchases (like television sets) and services (like telecommunications) that require monthly fees. Even expensive consumer items often become widely available at low prices once scale economies are reached and secondary markets develop. By contrast, monthly service fees place ongoing pressure on household budgets.

A third set of influences reflect the technology's fit with existing knowledge and practice, and the extent to which potential consumers can assimilate it to routines of everyday life. Historians have demonstrated that new technologies ordinarily shape themselves to the contours of existing practices, affording opportunities more than affecting behavior [Agre 1998]). In the short run, at least, technologies that are simple to use and reinforce familiar behavior patterns will diffuse more quickly than those that are difficult to use or require users to change their habits.

A fourth set of influences reflects the versatility of the technology. By versatility, we refer, first, to the number of uses to which the technology can be put; and, second, for information technologies, to the diversity of content that one can find on it. Other things equal, there will be greater demand for technologies that can be put to many uses. The greater the content diversity, the more similarly will members of different identity groups value the technology.

A final set of influences are institutional: first, strategies of the business enterprises that develop and distribute the technology and, second, policies of government. Business strategies enhance diffusion rates and reduce intergroup differences when firms subsidize initial adoption. They are likely to do this when programming is paid for by third parties (for example, when audience size augments advertising revenue) or when adopters must make recurrent purchases (for example, ink cartridges for printers). Businesses are more likely to cultivate small, segmented markets insofar as consumption entails negative externalities (for example, snob appeal or information of competitive value for which a few purchasers will pay a great deal). Government may stimulate a technology's development by subsidizing capital costs (which increases diffusion rates, but does not reduce intergroup differences). Or government may seek to reduce intergroup inequality by subsidizing (or mandating the subsidization) of adoption for groups based on income (e.g., policies that aim to keep the cost of local basic telephone or cable service low) or life-cycle stage (e.g., technology grants to public schools or senior centers).

Each of these sources of variation has different implications for inequality in access. (See Table 1.) Cost shapes inequality with respect to income (and characteristics or identities that are correlated with income). Infrastructure availability shapes inequality by place of residence (rural areas ordinarily have less well-developed communications infrastructures than urban places) and may make income more important (e.g., if the well-off can compensate for locational disadvantage through spending, as when prosperous rural dwellers purchase high-speed, high-cost Internet connections using satellite dishes). When users require knowledge or skill to make a technology useful, we are likely to see more inequality with respect to formal education (with more educated people better able

to learn how to use the technology) and age (with younger people more likely to receive training in school or at work).   Versatility should dampen intergroup differences and (other things equal) increase the rate of adoption. Versatility may also shape the competitive challenges facing innovators, with versatile technologies capable of competing on a number of fronts and avoiding direct competition with powerful existing media.   Business strategies or government policies that affect the costs and benefits of different consumer groups differentially may exacerbate or moderate inequality.

It follows from the heterogeneity of factors affecting adoption, and the differing position of groups with respect to these factors, that inequality based on different individual characteristics may vary sharply over the course of the diffusion process, with some groups attaining advantages early on that they lose thereafter (Bonus 1973; Van den Bulte & Lilien 2001: 1411).   We have already described the influence of network externalities on diffusion processes, and their dependence on the structure of subcommunity

Table 1: Factors Influencing the Rate of and Intergroup Inequality in Information Technology Diffusion

Influencing factor	Implication if high
Extent of network externalities *Instrumental* *Social (Membership, Identity, Prestige)*	Exaggerates nonlinearity in adoption pattern; the more that externalities are identity-specific, the more persistent will intergroup differences be, in proportion to the lack of interaction between group members, and the more network structure will matter
Location-specificity of distribution technology	Increases urban-rural/ metropolitan-nonmetropolitan inequality; often income inequality
Cost *One-time purchase price* *Is there an ongoing cost?*	The higher the price, the greater the impact of income on adoption. Income especially strong predictor of adoption of technologies that require subscriptions or other ongoing expense.
Complexity *Skill requirements* *Fit to existing routines*	High complexity (in both senses) leads to high educational inequality in adoption, and.advantages younger adopters.
Versatility *Functional versatility (variety of affordances)* *Content diversity*	Increases rate of adoption and reduces intergroup differences in adoption. Implications for competition (none, head-on, multiple fronts).
Institutional policies *Business strategies* *Government policies*	Third-party payments and ongoing expenses lead businesses to subsidize adoption. Government subsidies to disadvantaged groups reduce inequality.

networks and the prevalence of bridges among them. The impact of residence often declines over time as technical infrastructure is built out or delivery technologies become more sophisticated and powerful. The impact of income declines insofar as diffusion is accompanied by producers' exploitation of scale economies. The effects of education and age are likely to decline if technical interfaces become simpler and if new practices associated with new technologies become institutionalized and taken for granted.

These observations constitute an analytic framework and nothing more. It remains to develop these hypotheses through simulation modeling of adoption processes and to test such refined hypotheses through appropriate comparisons among individuals, technologies and national societies. In the remainder of this chapter, we illustrate the possibilities with a primitive comparison between diffusion patterns in the United States for two influential communication technologies: television and the Internet.

Television and the Internet: An Heuristic Comparison

Recall that this inquiry began with the following question: Does inequality in access to the Internet reflect the differing rates at which different groups are proceeding along a single trajectory; or does it represent intractable patterns of disadvantage such that differ-ent groups will follow fundamentally different trajectories with different outcomes. Our goal, then, is to develop a comparative framework to explain variation in the trajectories of different information and communications technologies, including the extent of inter-group inequality during and at the end of the diffusion process. In this section, we apply the framework developed in the previous sections of this paper to a comparison of tele-vision and the Internet, focusing on the first decade or so of the market for each.

Comparing Television to the Internet

How do television and the Internet compare on the salient dimensions identified earlier in this chapter?   Table 2 summarizes key differences that are posited to influence the rate and trajectory of diffusion and the degree and persistence of socioeconomic inequality.

Externalities. One important difference is that the Internet possesses much stronger network externalities than television. Many of the most popular Internet-based programs (electronic mail, instant messaging, peer-to-peer networks, auction sites, and various kinds of interactive spaces) are valuable in proportion to the number of people who participate.   Moreover, many of these network externalities have high levels of specificity with respect to the particular persons who participate.   In addition to the pure economic externalities, there are also important social-identity externalities, as the Internet generates new areas of expertise and new materials for the construction and maintenance of distinctive identities and status cultures.   The strength of these network externalities would lead us to anticipate (other things equal) a slow takeoff and then a rapid diffusion. (The strong network character would suggest a very steep upward trajectory, but the fact that the affordances that possess strong externalities are relatively loosely coupled [i.e., likely to appeal to somewhat different sets of users) would tend to moderate the explosive character of growth.) *The high level of network specificity (i.e., the fact that people care for many purposes who the other users are) leads us to expect a diffusion process characterized by considerable lumpiness (as different networks join up more or less en masse when local tipping points are reached) and persistent intergroup inequality (especially among groups with relatively low rates of social interaction).*

By contrast, television was characterized by a lower-specificity societal-membership externality, based on the importance to most people of being able to exhibit familiarity with "what everyone is talking about," as the latter increasingly is defined by what appears on the television screen.   (Note that although the strength of this factor may have declined with the growth of cable channels and the increasing segmentation of the audience after the mid-1980s [Turow 1997], we are here concerned with the period of network dominance during the 1950s.)   Television also indirect and nonspecific externalities in the form of scale economies, as increased viewership led to higher advertising rates and higher production budgets.   *Such externalities should have been adequate to produce*

Table 2: Television vs. Internet: Relevant Similarities and Differences

	TELEVISION	**INTERNET**
Economic Externalities	*Indirect*: TV ownership (and viewership) provides basis for advertising which encourages more expensive programming and investment in new transmitters and local stations	*Direct:* many uses including e-mail, auctions, peer-to-peer file-sharing, and some software *Indirect*: patronage produces advertiser support of sites (in theory)
Social externalities	Strong societal-membership externalities	Group identity *and* societal membership
Location-specificity	Strong regional specificity, weak within-metropolitan specificity	Moderate within-region specificity; weak regional specificity
Cost	*Product*: Television sets – declining price over time (starting at c. $3000 in year 2000 dollars in 1948), comparable to computers but higher relative median income in earliest years (although cheaper by 1960s) *Service*: Free	*Product*: Computer – declining price over time (although price rises quickly with quality, which keeps increasing) *Service*: Continuing fee, rising with connection quality, some reduction with scale
Complexity	Simple technology/ Relatively easy fit to radio routines	Relatively complex technology/ less easly adapted to existing routines
Versatility	Low: Single use, mass programming	Very high: Multiple uses, very diverse programming
Competition	Head on with radio, cinema	Modest niche overlap with many media, head on with none
Institutional Policies	Powerful business and content model from radio; controlled by established radio networks	Few business models; no clear content models; programming highly competitive with few barriers to entry, especially in early years

an S *-shaped diffusion curve with a steep trajectory, but (other things equal) their lack of*

specificity would tend to encourage relative intergroup equality.

   Technological infrastructure.   Different communications media distribute in-

formation in different ways, and the technology of distribution places constraints on both

overall adoption levels and the opportunities of members of different groups.   Early

television depended upon broadcasting by stations whose signals were largely confined

within metropolitan limits.   In the early years, then, the effective ceiling on the U.S. tele-

vision adoption rate was the percentage of Americans living within range of a broadcast

station, which was just over half in 1950. By 1954, with 95 percent of the population

with broadcast range, space was no longer a significant constraint (Bogart 1972).

   It is less easy to generalize about the Internet because of the variety of means

through which it can be accessed.   Most Americans with telephones can access the Int-

ernet through telephone hook-ups, an arrangement that puts service within reach of the

vast majority, but penalizes certain groups (Native Americans on rural reservations; per-

sons in low-income urban communities [Mueller and Schement 1996]).   And cell phone

users can access the Internet wirelessly (if slowly) in most of the U.S.   (Wireless is even

more available and considerably more popular in East Asia and Europe.)   Access to

high-speed Internet, on the other hand, has been more vulnerable to technological limitat-

ions: DSL service, for example, is available only to consumers whose homes are relative-

ly close to originating servers; and effective cable service has been available only in com-

munities with relatively modern cable infrastructures. Complicating matters even further,

wealthy consumers can turn to more expensive solutions (e.g., satellite dishes in rural

communities) unavailable to their less well-off neighbors.   Considering all this, *we antic-*

ipate that region had a large effect on television adoption in the early years but that its effect became negligible by 1957; and that rural areas experienced a significant but declining disadvantage in Internet adoption.

Cost. Early television and Internet service were both expensive, albeit in different ways. The average retail price for a television set was around $400 in 1948 and fell to $308 by 1951 (Machlup 1962: 253; Spigel 1992: 32). Taking account of inflation, these prices were roughly the equivalent in 2000 dollars of $3000 and $2200 respectively. This price was similar to the cost of name-brand personal computers in the early 1990s. Both costs declined, though television prices fell a little more quickly than those for computers.[3] For both television sets and computers, bargain-hunters or shoppers willing to take a chance on the resale market could purchase units for well under the median, and consumers wanting state-of-the-art devices could pay considerably more.

There is an important difference, however, in the cost structure of television in the 1950s and the Internet in the 1990s. Television involved a one-time purchase: Once one bought a television receiver, programming was free. By contrast, Internet service required an ongoing service charge, the price of which declined, but only modestly, in the early 2000s. Moreover as the Internet developed commercially in the late 1990s, site designs came to rely more heavily on detailed graphics and java applications and more uses emerged that entailed downloading large files. By the end of our time series, users would find it difficult to access many services without high-speed DSL or cable connections that cost between $20 and $60 per month.

Data on the diffusion of communications devices suggests that the presence of ongoing expense is a greater economic impediment to diffusion than one-time purchase

costs, even when prices are high.   Compare, for example, the rapid diffusion of radio to

the slow and uneven progress of telephone service which, despite a federal policy of

universal service, took half a century to reach 90 percent penetration; or compare the

glacial progress of cable television service to the nearly instantaneous acceptance of

VCRs (DiMaggio et al. 2004). *Consequently, we anticipate that while income would*

represent a significant predictor of adoption for both television and the Internet in the

earliest years, in the longer run low incomes would remain a more obdurate barrier to

Internet access.

      Complexity.   Of the two media, the Internet is by far the more complex, requiring

greater skill, experience, and assistance to use effectively than television (Hargittai 2002).

Moreover, the returns to skill in utility – that is, the difference between what an exper-

ienced and inexperienced user can obtain – is far greater for the Internet than for televis-

ion.   To be sure, the Internet has become more user-friendly over the years; and many

Internet users restrict themselves to relatively easy-to-use services (for example, e-mail).

Nonetheless, the difference is still very significant.   Consequently, *we anticipate that*

educational attainment will be associated with Internet adoption and not with television,

and that its influence will remain strong over time.   Moreover, although the young tend

to be among the first to adopt most new technologies, we anticipate that *the advantage of*

the young will persist longer for Internet adoption than for use of television.

      Versatility. The Internet provides many affordances, television only one, that of

entertainment. The Internet serves as an instrument of two-way communication, as well

as a source of entertainment, news and information, and a means of shopping and acquir-

ing education. One might, for this reason, expect it to be widely attractive, its utility perhaps outweighing its complexity.

Internet programming is also far more diverse in content and perspective than television (though television in the early days featured more highbrow programming that it would in later years). Television's mass appeal enabled it to serve as a primary source of common knowledge and social membership (Neuman 1991). By contrast, the Internet can sustain the identities of small, spatially dispersed communities. Although critics have noted that relatively few sites specialize in offering information or services to Americans of color (Kolko, Nakamura and Rodman, eds., 2000), the Internet certainly features more culturally specific "programming" than did early television. *Thus one might expect weaker effects of race and ethnicity on Internet than on television adoptions.*

Institutional context. Television competed directly with radio and film. Because the same networks that had dominated radio broadcasting also controlled television broadcasting, the succession was relatively smooth. (Radio listenership declined as radio's function changed, and radio programming evolved accordingly, shifting from dramatic series and spectaculars to demographically specialized musical formats.) Television's effect on film is ordinarily held to have been more devastating, with a dramatic decline in cinema attendance attributed to television's rise. Baumann (2001), however, contends that the film audience had already started to decline before the expansion of the television audience, due to the post-war baby boom, which restricted the mobility of young adults newly burdened with parental duties. The Internet, by contrast, competed obliquely with many sources of information and communications at once, without entirely supplanting any, initially at least. The Internet's rise has eaten into, but not yet

devoured, the markets for postal delivery, long-distance telephone service, television, recorded music, and, increasingly, film. Because of its versatility, it has not needed to dominate any of these niches in order to succeed.

Government regulation of broadcasting primarily addressed the broadcast spectrum and the number and distribution of broadcast stations (Owen 1999). It shaped the structure of the television industry, the nature of competition (and therefore of programming), and the pace at which the television audience expanded. Government policy towards the Internet was more facilitative, fostering the commercialization of the medium after 1995 and investing in programs to ensure that schools and libraries offered Internet access. Efforts to use public schools to provide Internet competency, if successful, will in the long run have egalitarian effects. In the short run, however, they reinforce the advantage of the young.

Television was supported by advertisers, who first sponsored entire programs and later paid rates based on the number of viewers that particular shows could command. Viewership research in the early years was relatively primitive, treating all viewers as equivalent, regardless of the economic resources at their disposal. Consequently, incentives for television producers rewarded audience expansion over niche marketing. By contrast, commercial development of the Internet has concentrated on high-end consumers, while noncommercial development has been driven by institutions of higher education. *On balance, then, television's institutional context militated towards a declining effect of socioeconomic status on adoption; whereas the Internet's institutional context, despite competing influences, has tended to reinforce the importance of education, income, and youth.*

Predictions: Given the preliminary nature of the theoretical framework and the inadequacy of our data, it would be premature to generate formal hypotheses.   At the same time, our theoretical framework facilitates an analysis that does lead to some general expectations about the difference we would expect in the diffusion of the television and the Internet.   The least controversial (and most banal) prediction is that the diffusion of each would follow the usual S-pattern of slow start-up, rapid ascent, and eventual leveling off.   The Internet's progress might be expected to be more explosive because of the strong network externalities associated with its use; at the same time, adoption would be smoothed by the variety of groups attracted by the medium's versatility and impeded by the cost of Internet service.

At the same time, we would anticipate that the Internet's diffusion would level off at a lower rate of penetration, due to the constraining effect of subscription service; and that the effects of income would remain significant longer than was the case for television.   Because of the Internet's complexity, we would anticipate that educational attainment would remain a strong predictor for Internet adoption but not for television adoption; and that the advantage of the young would also persist longer for the Internet. By contrast, we would anticipate a swifter effacement of the net effects of race and ethnicity on Internet than on television adoption, due to the more varied content on the former.

Data

We sought data that could capture the first few years during which television and the Internet were commercialized.   We required micro-data in order to be able to plot group-specific diffusion rates and to analyze adoption in a series of repeated cross-sections for each medium.   We would have preferred data that were fully comparable, but we could

not find them. Incomparability between data for the Internet and for television, and

within each over time, renders our results less precise than we would like. Nonetheless,

the analyses, crude as they are, suffice to illustrate our theoretical argument and to reveal

interesting features of the two cases.

Data on Internet access are from supplements to the Census Bureau's Current

Population Survey (CPS) fielded in 1994, 1997, 1998, 2000, and 2001. These supple-

ments were sponsored by the National Telecommunications and Information Agency

(NTIA), a bureau of the federal Commerce Department that has taken the lead in policies

aimed at achieving universal telephone service and, during the Clinton years, expanding

access to the Internet.[4]   The CPS provides data for individuals and for households.   In

this paper we report analyses at the individual level. Internet users are those respondents

and household members who used the Internet *either* at home *or* outside the home.

Data on television are from the 1949 to 1951 Surveys of Consumer Finances

(SCF) (Economic Behavior Program 1949; 1950; 1951)[5]; and from the News Media

Study (NMS) of 1957 (Withey and Davis 1957).[6]   SCF respondents were asked as part

of a series of questions about purchases: "How about such large items as furniture, a re-

frigerator, radio, television set, household appliance and so on - Did you buy anything of

this nature during the past year, [calendar year before year of survey]? If Yes, what did

you buy?" Thus SCF data indicate whether respondents had *purchased* televisions sets

during the previous 12 months, not whether they owned them. They therefore underest-

imate television ownership insofar as respondents owned television sets purchased in pre-

vious years or given them by others; and overstate it insofar as respondents report pur-

chases of television sets for others (for example, parents buying units for adult children).

Thus these data provided suitable proxies for in-home access only in the earliest years of

television's diffusion, when one could assume that vast majority of people who had not

purchased a TV set during the year of the survey were unlikely to have purchased one in

the past. We concluded our analyses with the 1951 SCF (which recorded purchases made

in 1950), because by that point too many households --- 3.875 million as opposed to just

940,000 the year before (Rubin and Huber 1986: 142) --- owned television sets for that

assumption to remain tenable.

To examine the correlates of television adoption at a latter stage in its diffusion,

we used data from the NMS, a 1957 survey on behavior and attitudes related to news me-

dia, which asked respondents "Do you ever watch television?" These data overestimate

household access by including respondents who watched television at the homes of relat-

ives, friends, and neighbors but did not own sets themselves. (The effect is slight: a sur-

vey of Kansans in 1953, when television service was new to much of the state, reported

that 14 percent of viewers watched television only outside the home [Bogart 1972], a

figure that would have been much lower for the national population four years later.)

Our decision to treat the years 1948 and 1994 as starting points reflects a combin-

ation of convenience and conviction.   Although the FCC authorized commercial televis-

ion broadcasting in 1941, the war effectively halted the medium's development. Televis-

ion began to take off in 1948: whereas 6500 sets were manufactured in 1946 and 179,000

in 1947, nearly one million were produced in 1948.   Although aggregate penetration was

low (in part because there were so few stations outside of the New York area), adoption

rose quickly thereafter, with new stations opening throughout the U.S. (slowly at first,

and more rapidly once the FCC lifted regulatory restrictions in 1952) until 95 percent of

Americans were within broadcast receiving range by 1954 (Bogart 1972). By 1957, when the News Media Study was undertaken, television's penetration rate had reached nearly 80 percent.

The Internet was unleashed by a combination of the gradual development of graphical interfaces (browsers), which first became widely available in 1993, and regulatory change encouraging commercialization in 1996. In 1994, the first year from which CPS modem-ownership data are available, penetration was still under 4 percent. Internet use began to spiral upward in 1997, with adoption leveling off between 2000 and 2001 at approximately 60 percent of households.[7]

In other words, the periods 1948 to 1957 and 1994 to 2001 represent comparable eras in the histories of the two media. Each medium had existed as a technical possibility with specialized noncommercial uses for more than a decade before the starting point. In each case, the proportion of adopters at the onset of the series was in the very low single digits. For each, diffusion grew rapidly approximately three years after our starting date and continued throughout the period under investigation.

Results

Figure 2 compares the diffusion of the Internet to that of television. In 1948, less than one out of every hundred households possessed a television receiver. In 1994, 3.4 percent of households used e-mail from a home computer. Data for the Internet are from the Current Population Surveys. Television data for 1950 through 1957 were assembled by Leo Bogart (1972) from research by A.C. Nielsen, NBC, and CBS; 1948 and 1949 data are from Kurian (1979).

The two media followed rather similar paths; but television diffused more quickly than did the Internet, pulling ahead by year four (even before television signals became available in many parts of the United States, and while prices were still high), with the gap increasing in years five through eight. Television's entry into 80 percent of U.S.

**Figure 2: Television and Internet Diffusion in the U.S.**
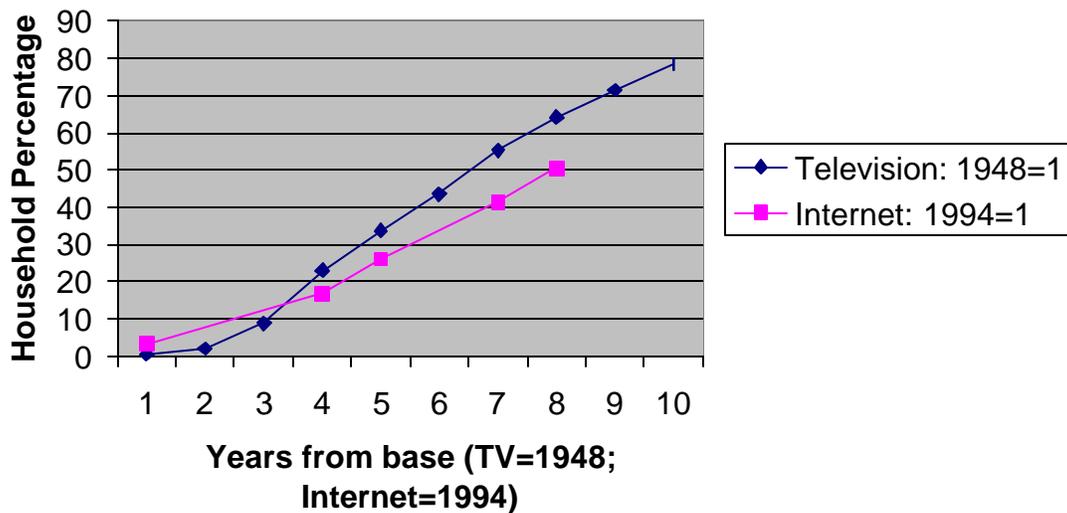
Sources: TV: Bogart 1972; Internet: NTIA 1994 (modem), 1997, 1998, 2000, 2001

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households by 1958 --- a degree of penetration substantially greater than that of radio during its first decade --- reflected not only the appeal of its programming, but also its relatively easy assimilation into the lifestyles of viewers who had for years followed many of the same programs on radio; its simplicity of use; the fact that its operation was effectively free, and the powerful social-membership externalities that it quickly came to generate (Butsch 2000). By contrast, for all of its utility and appeal, the Internet diffused more slowly due to its novelty and strangeness (especially to older Americans), its complexity, and the ongoing service charge. Whether the strength and specificity of network

externalities contributed to the rapidity of the Internet's rise (by creating a series of little

tipping points for separate user publics) or slowed the rise (due to the absence of network

bridges between different user publics) cannot be discerned from these data.

What about diffusion trajectories for different subgroups?   Figure 3 reports sub-

group Internet adoption rates for subgroups on the Internet based on analysis of individ-

ual-level CPS data; and reports constructed pseudo-adoption rates for television, based on

SCF data for 1948 through 1950, with rates for 1957 calculated from the News Media

Survey.   We constructed the SCF rates by adding the percentage purchasing television

sets each year to the percentage in each subgroup that had purchased them in the previous

years. The assumption that television purchasers in this era did not already own a set is

reasonable: as late as 1957, only 6 percent of households owned more than one television

set [Bogart 1972: 13]). This procedure exaggerates the slope of the increase from 1950 to

1957 (more people watched television than bought television sets), but intergroup com-

parisons in each year are probably sound.   As anticipated, initial differences in television

adoption were driven primarily by income, reflecting the high cost of television receivers

in the early years.   By 1958, income differences had moderated, although well-to-do

families were still surprisingly (given the lack of an ongoing service charge) more likely

to own television sets than were the poor. Differences between whites and nonwhites in

television set ownership were modest in the early years, but grew somewhat over the

course of the 1950s.   By contrast, college graduates were only slightly more likely

Figure 3. Television and Internet Household Adoption Curves for Selected Household-Head/Respondent Sub-Groups
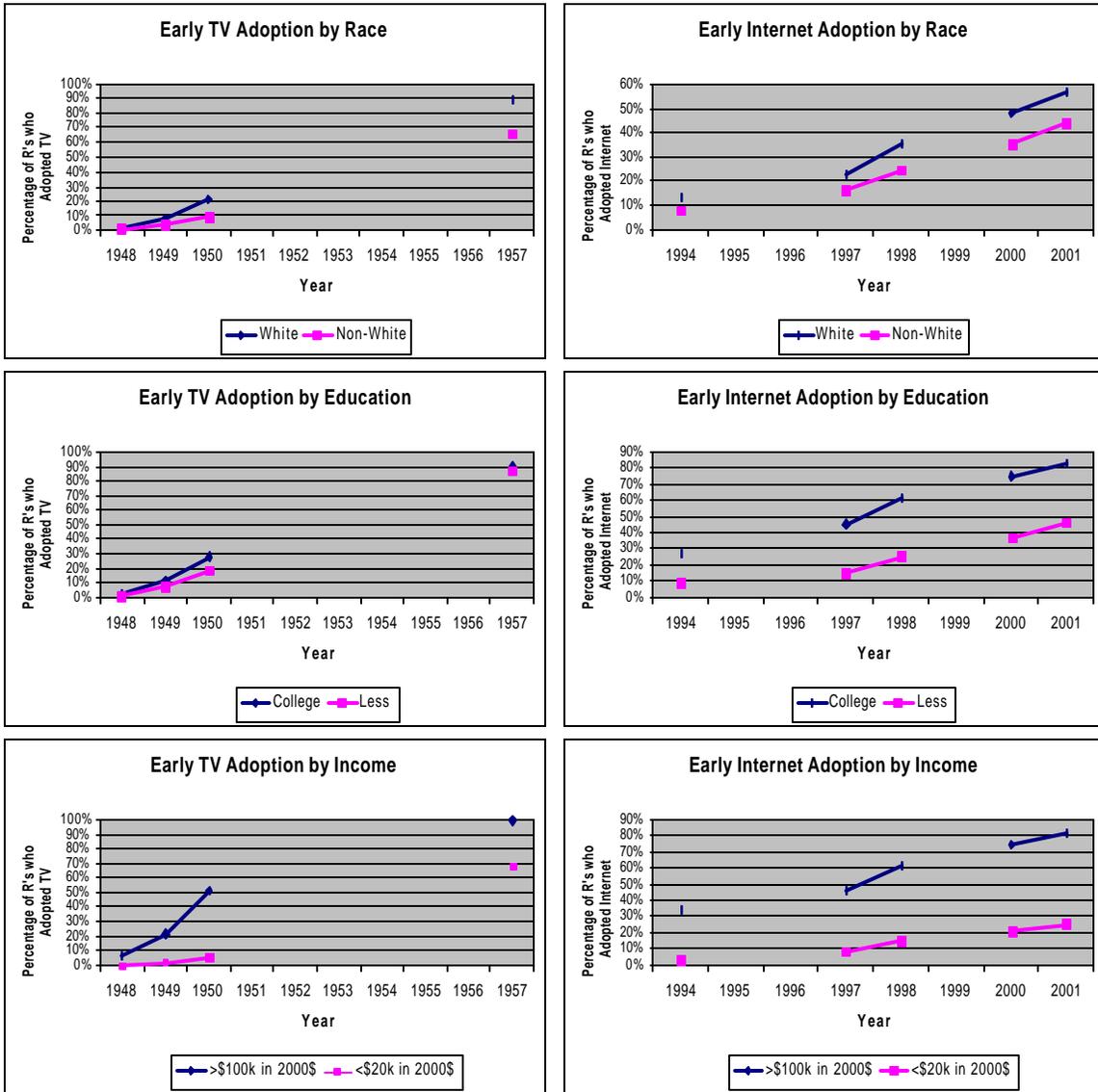
Data on television are from 1949, 1950, and 1951 Surveys of Consumer Finance (SCF) and 1957 News Media Survey. SCF data refer to purchases of television sets in the previous year and penetration rates for 1950 and 1951 are derived by summing previous years in the series. NMS data refer to television viewing, not ownership. Data on Internet are from Current Population Surveys of 1994, 1997, 1998, 2000, and 2001 and refer to Internet use. The 1994 survey referred to ownership of "modems" rather than use of Internet, so also include connections to dedicated networks.

to purchase television sets than persons without college training, and this difference evaporated entirely by 1957.

By contrast, and consistent with expectations, differences in Internet adoption between college graduates and persons without education beyond high school were notable in 1994 and remained substantial through 2001. Similarly, income inequality in Internet adoption remained strong, with penetration rates starting higher and growing more quickly among prosperous than among poor Americans throughout the 1990s. Racial differences, by contrast, were somewhat smaller, but still substantial and persistent. (For review of a wider range of evidence indicating the persistence of racial, educational, and income inequality in Internet use see DiMaggio et al. 2004.)

Figure 4 explores Internet diffusion rates in more depth by providing exponentiated results (odds ratios) from logistic regressions of Internet use against selected independent variables (income and dummy variables for college, postsecondary and high-school education, male gender, white-collar occupation, student status, African-American racial identification and Hispanic ethnic identification). By using controls, we are able to isolate more effectively the continuing effects of particular factors over this period.

We emphasized that the complexity of a technology is likely to exacerbate differences in adoption rates based on education and, indeed, the advantage accruing to education increased throughout this period. College graduates were almost ten times as likely to be on-line as persons without high-school degrees in 1997 and nearly nine times as likely through 2001. The advantages of high-school graduates and persons with less than four years of college were considerably less but still substantial, and constant throughout this period.

Figure 4: Odds-Ratio Estimates of CPS Logit Models, 1994 to 2001
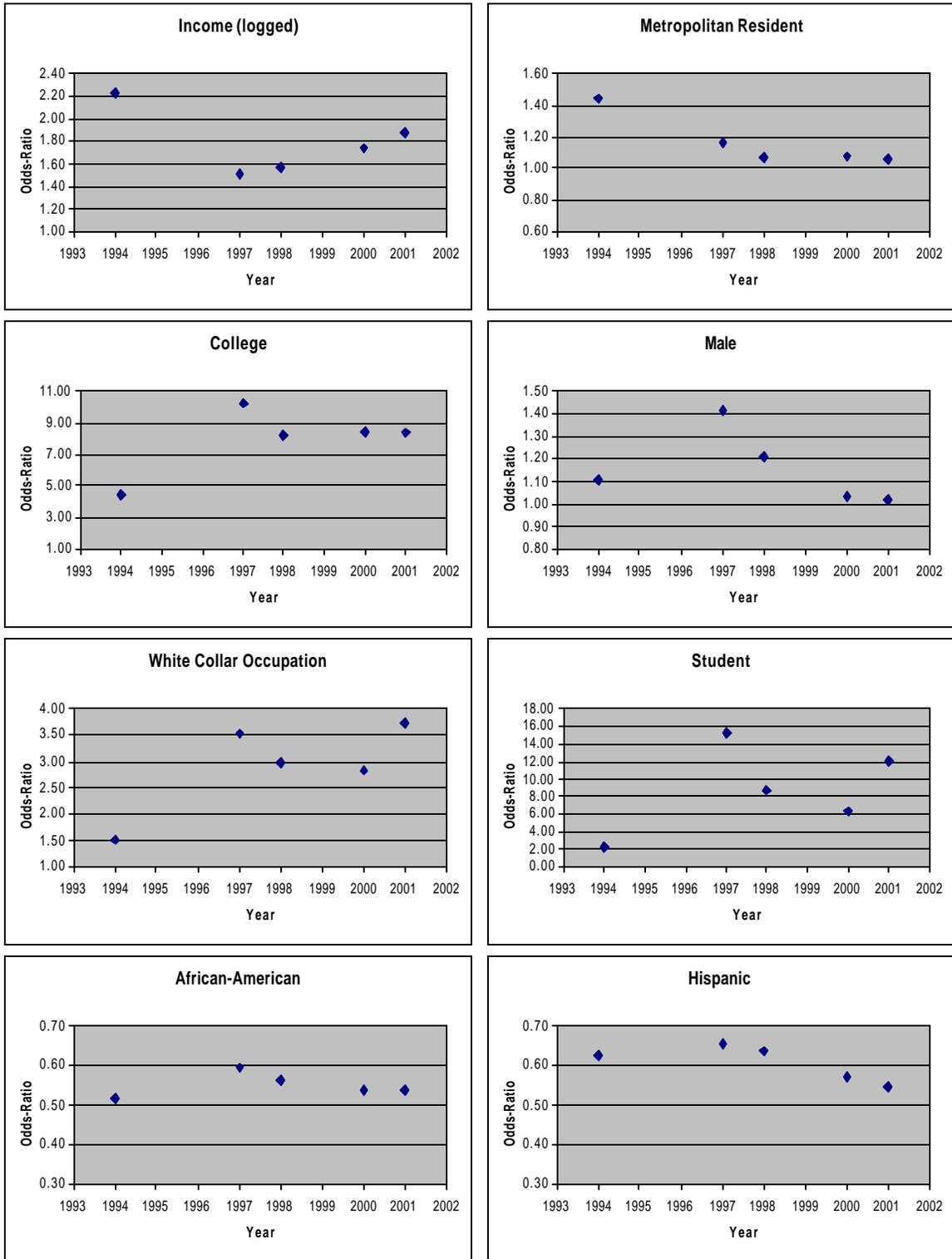
Source: Current Population Survey. Coefficients generated from regression of Internet connectivity on log income and dummy variables for college graduation, some postsecondary, and high school education, male gender, white-collar occupation, student status, African-American racial and Hispanic ethnic identification, and metropolitan residence.

We also argued that the existence of continuing service costs would render income inequality persistent. The impact of income was less in the 1997 than in the 1994 model (probably because income has less of an effect on Internet use than on owning a modem), but increased monotonically from that point on.   The advantages of white-collar workers and students as opposed to persons with other employment statuses fluctuated during this period, but remained substantial.

Gender inequality in Internet use disappeared (by 2001 women were more likely to be on-line than comparable men). By contrast the disadvantages associated with being African-American remained constant and those associated with being Hispanic increased. These results probably reflect the specificity of Internet externalities and the degree of social separation between networks of English-speaking whites and those of African-Americans and Hispanic Americans, respectively..

It may be useful to focus in greater depth on the impact of various factors on adoption at different points in the diffusion process.   Rather than exaggerate the degree to which our data sets are comparable by using the same models throughout, we acknowledge the exploratory nature of this enterprise and use different predictors based on their availability in different data sets. (This means that our results are only loosely comparable, but given differences in measurement of the dependent variables, this would be the case even if we *had* used the same models.)

Table 3 reports predictors of television purchase in surveys from 1948, 1949, and 1950, in which years 1.5, 6.3, and 15.0 percent of respondents (respectively) reported buying a set.   Table 4, reports predictors of television viewing in 1957, when penetration was close to 80 percent.   In the early period, the importance of infrastructure was para-

mount, with metropolitan residence a highly significant predictor of television ownership. By 1957, with 519 television stations operating (compared to just over 100 in 1951), metropolitan residence mattered much less.

Income was also an important predictor of television purchases between 1949 and 1951, not surprisingly given the high cost relative median income. More surprisingly, income remained an important predictor of ownership in 1957 (by which time television had reached majorities of all but the poorest Americans). Families with children were particularly likely to purchase television sets (although the effect of additional children turned negative as families grew in size). This may reflect some combination of three factors: the role of older children as lobbyists for the new technology; the utility of tele-

Table 3. Logistic Regression Models of TV Purchase, 1948 to 1950 (Survey of Consumer Finances)

Year	1948			1949			1950		
Metropolitan	4.7369	***	1.6356	5.6576	***	0.9737	3.6123	***	0.4125
Male	3.1528		3.2611	1.8933		0.8129	2.5791	**	0.8142
White	0.8084		0.6230	2.2661		1.2050	1.5105		0.4507
Married	NA			1.8350		0.5899	1.8900	**	0.4445
Age	0.9900		0.0167	0.9947		0.0072	0.9998		0.0050
Income (logged)	2.5070	***	0.5738	1.9535	***	0.2707	1.6903	***	0.1580
White Collar	1.9051		0.7518	0.9577		0.1701	1.1879		0.1526
Unemployed	ELIM			0.5545		0.2952	0.6593		0.4011
Retired	ELIM			0.2818	**	0.1348	1.1097		0.3385
Number of Children	1.7889	**	0.3686	1.3384	**	0.1377	1.2051	**	0.0851
Children ^{squared}	0.8439	*	0.0727	0.9401		0.0359	0.9398	*	0.0250
High School	0.5729		0.2439	1.0822		0.2156	1.2885		0.1864
College	0.6744		0.3063	0.7395		0.1841	1.0121		0.1817
N	2,733			3,408			3,315		
Pseudo R-Squared	18.78%			19.11%			14.72%		

Coefficients reported in odds-ratios; standard errors in italics
***p<0.001, **p<0.01, *p<0.05,
Individual characteristics pertain to household head, not respondent; ELIM=Eliminated from analysis because predicts outcome perfectly; NA = Not Available

vision as a babysitter; and the desire of parents of small children for substitute entertainment given their inability to seek entertainment outside the home as frequently as when

they were childless. (Baughman[1992] and Baumann [2001] note that movie attendance began to plummet at the start of the post-war baby boom, before the rise of television.)

By 1957 television was firmly established in American households, with or without children. Television in the early years was an intensely social medium. In the 1940s, it was primarily watched in bars, which used television sets as a means to attract patrons. Once it moved into the home, the living rooms of early adopters often attracted neighbors and friends to showing of favorite programs (Butsch 2000). Consistent with

Table 4. Logistic Regression Models of TV Viewership, 1957 (News Media Study)

Metropolitan	1.7241	**	0.3092
Male	0.9346		0.1653
White	2.8462	***	0.6686
Age	0.9780	**	0.0069
Married	1.4000		0.2828
Income (logged)	2.1017	***	0.2378
White Collar	0.8895		0.2169
Unemployed	0.9185		0.4302
Student	0.3804		0.4628
Retired	0.8962		0.2576
Number of Children	0.9391		0.0502
Number of Group Affiliations	1.5286	***	0.1563
Church Attendance	0.8667		0.1519
High School	1.9219	*	0.5836
Some College	0.7917		0.2581
College	0.5413		0.2168
N	1,688		
Pseudo R-Squared	21.56%		

Coefficients reported in odds-ratios
Standard errors in italics
***p<0.001, **p<0.01, *p<0.05

the notion that television viewing represented a form of social membership, television ownership was significantly associated by 1957 with memberships in lodges and clubs. (Interestingly, this did not apply to membership in churches, which may have discouraged television viewing.)

Our analysis of the NMS data suggests that in 1957 no one was excluded from the circle of television but the poor (who still could not afford sets), the elderly (who may have rejected the new technology), and African-Americans (who possessed little wealth and who appeared rarely and unflatteringly in TV programming [Baughmann 1992: 56). Many college graduates excluded themselves, as the negative coefficient indicates, perhaps viewing television's embrace by the mass public as a kind of negative externality (Steiner 1963:33-34; 57-58) . (The proportion of college graduates who watched television was high, just not as high as one would have expected given the fact that they earned high incomes, were disproportionately white, and joined lots of associations.)

Table 5 provides a more detailed view of factors predicting Internet adoption from 1994 through 2001, adding additional covariates to the simpler model that generated the exponentiated coefficients reported in Figure 4. The exponentiated logit coefficients represent net differences in odds of adoption associated with particular characteristics or identities. Values greater than 1 indicate a positive impact on adoption, whereas values lower than 1 indicate the opposite.

College graduates maintained a very strong advantage (and one that grows relative high-school graduates) over this period. Similarly, the impact of income increased between 1997 and 2000. White-collar employees and students maintained a sizable advantage over other groups (with blue-collar workers the omitted category).[8]

Perhaps reflecting the importance of local networks, modest regional disparities have persisted, with the midwest and southeast falling behind as the northeast has caught up with the west. The development of technological infrastructure reduced the initial advantage of center-city residents, which disappeared by 2000. Suburbanites maintained

Table 5. Logistic Regression Models of Internet Adoption, 1994 to 2001 (Current Population Survey)

Year	1994			1997			1998			2000			2001		
Dependent Variable	Modem Ownership			Internet Use			Internet Use			Internet Use			Internet Use		
Metro Central	1.4159	***	0.0510	1.2573	***	0.0395	1.1785	***	0.0332	1.0861	**	0.0307	1.0350		0.0279
Metro Other	1.5232	***	0.0472	1.1536	***	0.0319	1.0599	*	0.0260	1.1031	***	0.0269	1.1108	***	0.0257
Income (logged)	1.9187	***	0.0444	1.4507	***	0.0259	1.4692	***	0.0242	1.6189	***	0.0261	1.6773	***	0.0250
Income (top code)	1.2542	***	0.0418	1.1711	***	0.0348	1.2385	***	0.0346	1.1693	***	0.0332	1.1789	***	0.0330
White Collar	1.3608	***	0.0373	2.8091	***	0.0709	2.3336	***	0.0503	2.2500	***	0.0483	2.9188	***	0.0620
Student	1.8504	***	0.0996	7.8607	***	0.3695	3.7431	***	0.1702	2.6677	***	0.1610	4.9673	***	0.2794
Unemployed	1.2392	**	0.0927	1.1291		0.0875	1.3784	***	0.0816	1.4895	***	0.0812	1.4086	***	0.0684
Retired	0.7617	***	0.0437	0.6563	***	0.0394	0.7683	***	0.0344	0.8767	**	0.0345	0.8853	**	0.0313
Disabled	0.9386		0.0921	0.5846	***	0.0615	0.8037	**	0.0546	0.7904	***	0.0444	0.7098	***	0.0346
Number of Children	NA			NA			NA			1.0301	**	0.0101	1.0423	***	0.0100
Age	0.9860	***	0.0010	0.9744	***	0.0009	0.9686	***	0.0008	0.9631	***	0.0008	0.9633	***	0.0008
High School	1.6845	***	0.0951	2.5561	***	0.1494	2.2518	***	0.0907	2.3250	***	0.0818	2.3295	***	0.0713
Post-Secondary	2.7585	***	0.1541	5.5152	***	0.3151	4.5249	***	0.1807	4.8582	***	0.1745	4.7952	***	0.1524
College or More	4.2000	***	0.2404	9.9811	***	0.5856	8.6454	***	0.3647	9.5477	***	0.3725	9.6163	***	0.3446
Married	1.3674	***	0.0363	1.1211	***	0.0263	1.0669	*	0.0224	1.1438	***	0.0252	1.2714	***	0.0264
Male	1.1006	***	0.0238	1.4144	***	0.0284	1.1965	***	0.0218	0.9756		0.0180	0.9329	***	0.0166
African-American	0.5360	***	0.0281	0.5617	***	0.0237	0.5058	***	0.0182	0.4737	***	0.0158	0.4768	***	0.0151
Asian-American	0.9955		0.0543	0.7231	***	0.0367	0.5851	***	0.0275	0.5356	***	0.0250	0.5576	***	0.0256
Hispanic	0.5378	***	0.0321	0.5181	***	0.0245	0.4544	***	0.0176	0.3833	***	0.0132	0.3592	***	0.0117
Mid-West	1.0975	**	0.0347	1.0390		0.0310	1.0196		0.0276	0.9786		0.0269	0.9360	*	0.0244
South	1.1047	**	0.0335	1.1103	***	0.0321	0.9839		0.0256	0.9407	*	0.0249	0.8691	***	0.0221
West	1.3737	***	0.0427	1.3381	***	0.0397	1.2982	***	0.0351	1.2188	***	0.0337	1.0632	*	0.0281
N	88,662			79,202			77,583			75,380			88,426		
Pseudo R-Squared	16.03%			25.94%			25.54%			28.64%			32.40%		

Coefficients reported in odds-ratios, standard errors in italics.

***p<0.001, **p<0.01, *p<0.05; NA=variable not available in set

Coefficient estimates for variable demarcating unidentified metropolitan region omitted.

a small edge over people living outside metropolitan areas, perhaps reflecting network externalities in the use of the Internet by schools and community organizations, or increasing use of superior suburban cable infrastructure for high-speed Internet access.

As was the case for television in 1957, youth was associated with Internet use throughout this period with little change from year to year, a difference that reflected the greater openness of the young to new technology, their greater familiarity with computers, and the premium placed upon the Internet by high schools (especially in the informal student culture) and, even more so, institutions of higher education.   Indeed, the emerging reliance of high-school and college students on instant messaging represents as pure a network-externality effect as one can find.[9]   Even controlling for age, full-time students maintained a substantial advantage over other labor-force-status categories.

Finally, as was the case for television in the early years, married people and parents were significantly more likely to use the Internet than were people without children. (Moreover, results not reported here demonstrated that, as was also the case for television, the positive impact of children declines as the number of children grows.)   The attractiveness of the medium to older children, its perceived educational value, and its usefulness in managing children's school and social lives probably share responsibility for this finding.

The relative position of Hispanics appears to have deteriorated over time; and African-Americans remain only about half as likely as similar whites to use the Internet throughout this period.   Surprisingly, despite high absolute rates of Internet use, Asian-Americans used the Internet less than sociodemographically similar Euro-Americans.[10]

Note that the Internet's relative content diversity would lead one to expect that Internet usage patterns for members of racial and ethnic minority groups would differ less from those of whites compared to television in the 1950s. At the same time, however, insofar as members of these groups are socially isolated as well as (in the case of Hispanics and African-Americans) economically disadvantaged, the networks in which they participate may be expected to have adopted the Internet *more* slowly than television due to the greater role of pure network effects in the diffusion of the former. In so far as network effects matter, we would expect that members of minority groups with characteristics like high levels of formal education or white-collar employment that are associated with lower levels of social isolation will adopt at a higher rate, relative whites, than people with less education or lower-status occupations.

We explored this possibility by adding two sets of interaction effects to the models reported in Table 5.[11] In one set of models we included interactions of the three educational levels with the three racial and ethnic identities. In a second set of models

Table 6: Race/Ethnicity Interaction Effects on Internet Use

Interactions	1994	1997	1998	2000	2001
BlackXHS	1.018	1.071	1.350	1.053	0.846
BlackX some college	0.983	1.607*	1.603**	1.167	0.953
Black X college	1.442	1.914**	2.004***	1.412**	1.129
Asian-American XHS	0.396***	0.959	0.912	1.260	0.802
Asian-Am. X some col.	0.492**	0.920	1.194	1.585*	0.869
Asian-Am. X college	0.557**	1.205	1.328	1.408	0.946
Hispanic X HS	1.331	1.680*	2.221***	1.858***	1.327***
Hispanic X some college	1.823**	2.466***	2.658***	2.138***	1.458***
Hispanic X college	2.438***	2.518***	2.522***	2.166***	1.471***
Black X white-collar	1.270*	1.528***	1.506***	1.296***	1.281***
Asian-Am. X white-collar	0.811*	0.880	1.034	1.223*	0.948
Hispanic X white-collar	1.620***	1.428***	1.421***	1.544***	1.384***

`*** p<0.001; ** p<0.01; * p<0.05; two tailed`

Education interactions and occupation interactions added (in separate models) to basic model predicting use of the Internet at any location from Table 5. Figures are exponentiated logistic regression coefficients, with values >1 representing smaller differences from white rates for group members with the indicated trait than for the group as a whole. 1994 data are for modem in the home.

we included interactions of the latter with white-collar employment. The exponentiated logistic regression coefficients in Table 6 represent the extent to which adoption rates differ less (for values greater than 1) or more (for values less than 1) from the white rates for group members with the indicated characteristic than for other group members.

For African-American and Hispanic respondents, the results are consistent with the proposition, based on the network-externalities framework, that group-specific adoption rates are retarded by social isolation. For Blacks, white-collar employment appears to be especially important, although in most years African-American college graduates differ less from their white counterparts than do less educated African-Americans. For Hispanics, occupational status *and* educational attainment both have large effects, with higher education substantially reducing inequality, and even high school graduation having a strongly beneficial effect. Educational effects for both African-Americans and Hispanics, and occupational effects for Blacks, have tended to decline over time, perhaps reflecting within-group diffusion to less elite networks.

By contrast, neither education nor occupation has a consistent impact on net differences between Asian-American and Euro-American rates of use. We have no way of knowing whether this reflects the relatively small size of the Asian-American samples (especially given the heterogeneity of this population) or something distinctive about patterns of Internet diffusion in Asian-American communities. Although the results certainly do not support a network-externalities interpretation, neither do they in themselves disconfirm it. (From a network perspective, we would expect such results if Internet use had been high enough within homophilous Asian-American networks that contact with outsiders was unnecessary to stimulate diffusion; or if white-collar employment and high-

er education had less of an impact on outgroup contact for Asian-Americans than for African-Americans or Americans of Hispanic descent due to strong enclave economies.)

For the most part these findings are consistent with the six predictions that emerged from our comparison of television and the Internet in the light of our analytic framework. First, as predicted, Internet and television diffusion both roughly fit the expected logistic pattern, with the former leveling of earlier than the latter. Second, also as predicted, regional effects on television were stronger than on the Internet, whereas rural/metropolitan differences were important for the Internet, and both declined in importance over time. Third, as predicted, income had a significant effect on the adoption of both television and the Internet and persisted in its effects on Internet adoption; but its effects on television adoption declined less quickly than we anticipated. Fourth, as anticipated, both age and, especially, educational attainment were more strongly associated with Internet than with television adoption, especially after the first few years. Fifth, contrary to expectations based on content versatility, but consistent with rough intuitions about social homophily and network effects on adoption, racial and ethnic effects on Internet adoption remained strong. Finally, as noted and with some exceptions, sociodemographic factors have tended to have more persistent effects on Internet adoption than on television adoption, a finding also consistent with the framework developed earlier.

Conclusion

The development of capitalism over the past two centuries has been marked by growing interdependence of markets and consumption. From the autarchy of agricultural communities through the small-scale production of early capitalism; from the emergence of the factory system, which ushered in mass production, economies of scale and, ultimate-

ly, mass consumption, to the rise of flexible production and the use of consumption as a means of defining shared identities as well as satisfying needs, goods and services with network externalities have played an increasingly important role in both economy and society.   When the economist Fritz Machlup (1962) first called attention to the growing importance of the United States's information economy, with its strong network properties, almost half a century ago, he could not have imagined the extent to which the Internet revolution of the 1990 (in combination with the loss of most of the traditional manufacturing sector) would bring his vision to fruition.

In this paper we have tried to accomplish three things. First, like the other authors in this volume, we have exploited insights from the field of economics, specifically the notion of "network externalities." And, like others, we have prodded and stretched as we have borrowed, rendering the concept more sociological in three ways: calling explicit attention to *social*-network externalities that are as real in their consequences as purely instrumental effects; making a case for treating "network-ness" as a continuous variable rather than a binary classification; and distinguishing between two correlated but analytically independent dimensions of variation in network goods (the degree to which their use entails social interaction and the extent to which users care about the specific identities of other consumers).

Second, we have developed a systematic analytic framework for understanding differences in the diffusion patterns of new technologies, especially new technologies of information and communications with at least some of the properties of network goods. In particular, we are interested in explaining the rate of diffusion, the extent of diffusion, and the degree of socioeconomic inequality in adoption over the course of the diffusion

process. The framework described in this chapter should be useful both for comparing the trajectories of different technologies within societies and for comparing the trajectories of similar technologies across different societies.

Third, we have illustrated the utility of this framework in the context of a comparison between the diffusion of television between 1948 and 1957 and the diffusion of the Internet between 1994 and 2001, both in the United States. Each of these media was enormously successful in its first years; each was initially constrained by spatial factors that became less important as the technological infrastructure developed; and each appealed especially to young people and their parents. Yet there were also significant differences that are explicable with reference to the analytic framework presented here, especially the lower level at which Internet penetration began to plateau and the persistence of socioeconomic inequality in its distribution. This analysis also demonstrates the utility of our framework for policy-analytic purposes by answering a question that has been a source of much contestation in the communications-policy field: The "digital divide" is *not* simply developmental, but is likely to persist indefinitely, at least in the absence of concerted public action.

The analyses presented here, both theoretical and empirical, are preliminary and crude. The theoretical framework needs further development, ideally with the use of computational models to illuminate the less intuitively obvious implications of different forms of social-network externalities. And the empirical analyses would benefit from the application of better data to more technologies in cross-national perspective. Joining with this volume's other authors in the attempt to integrate insights from economics and sociology in order to better understand the capitalist economies of the 21st century, we

hope that we have provided a start to the comparative analysis of goods and services

depending on technical systems with network externalities, on which others can improve.

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Endnotes

[1] Economists use the term "externality" to refer to positive or negative consequences of the production or consumption of a good or service that are not captured by or charged to the producer or consumer. The particular class of externality upon which we focus in this paper comprises cases in which one person's consumption of a service generates utilities from which other consumers benefit.

[2] Some economists have modeled the influence of social relations on consumer decision-making (e.g., Leibenstein 1950; Akerlof 1997), but of the ones we have seen, only Shy (2001: ch. 10) does so in the context of network externalities.

[3] The SCF asked respondents the price they paid for their television set by dollar ranges. Taking the median of these ranges for each year yields estimates ($425 for 1948 and 1949; $325 for 1950 for the median categories), similar to estimates based on retail surveys.

[4] In this paper we report analyses at the individual level, although the dependent variable in 1994 (modem ownership) can be interpreted as household connectivity. In 1994, respondents were asked if their household owned a modem attached to a telephone line, whereas from 1997 on the question referred to Internet service. Therefore, the 1994 data underestimate Internet use insofar as some respondents may have used a modem they did not own, and overestimates insofar as some respondents used modems to connect to dedicated networks that were not part of the Internet. Individual-level and household-level results for Internet penetration differ because some members of households with Internet connections do not use the Internet and because many people without household connections go on-line at school or work (DiMaggio et al. 2004). **Coding Notes for**

Current Population Survey. *Metropolitan* Status. The distinction between central and non-central areas of metropolitan areas is crucial to studies on Internet access inequality. However, the CPS variable that delineates central versus non-central areas of metropolitan regions (**gtmsast**) often has many missing values. The difficulty with this identification problem affects a large proportion of the data set (around 15% of respondents or more). To avoid losing too much data, the following strategy was used. First, within descriptive statistics, graphs and tables depicting metropolitan respondents do not differentiate between central and non-central residents (which allows us to use the **gemetsta** variable, for which there are substantially fewer missing values). However, within the regressions, members of unidentified groups were placed in a residual category, the coefficient of which is not reported in the tables of coefficients. *Occupational Groupings.* Occupational groupings (students, white- and blue-collar workers, unemployed, disabled and retired individuals) were placed into mutually exclusive categories. *White-collar* and *blue-collar* workers were categorized as such only if they were in the labor force at the time of the survey *and* did not claim to be full-time students or retirees. Disabled people in the labor force were included in the white- and blue-collar categories. *Students* are restricted to respondents who either (1) reported being full-time students who were not in summer vacation in the week prior to the survey, <u>or</u> (2) claimed to not be in the labor force because they were students. The use of these criteria is an artifact of the way the CPS assesses student status. Full-time students who claimed to have full-time jobs were placed in the student category, while part-time students were all placed within other occupational categories. *Disabled* individuals only include those who were not in the labor force during the survey. Respondents are categorized as *retired* if they

report being simultaneously not in the labor force as a result of being retired and report

having a profession. *Education.* Education is grouped into four categories: (1) less than

a high school degree, (2) completed a high school degree (including GED), (3) some

postsecondary schooling and (4) completion of a college degree or more. *Children.*

People who were coded as having missing values for number of children are described as

not being parents, and thus were assigned zero children for this variable. This variable

was only available after 1999. *Age.* Respondents who were top coded at age 90 were

represented as being 90 in the data set. *Income.* Respondents who were top coded at an

annual income of $75,000 or more were coded as having incomes of $100,000 in the data

set. *Modem Ownership.* Many observations in the modem ownership variable (**hesq2**)

were coded as blank. Those who were coded as having a computer (from **hesq1**) and

were left blank in **hesq2** were classified as not having a modem.

[5]C*oding Notes for Survey of Consumer Finances.* Survey years correspond to responses

given one year earlier. The number-of-children variable was top coded at 7 and recorded

as 7.5 children for the1949 and 1950 surveys, and top coded and coded at 9 in 1951. Age

was top coded at 65 and recorded at 70. In the 1949 survey, income was top coded at

$99,995 and recorded as $100,000. In all years, one dollar was added to the income to

define its log when income equalled zero. In 1950, the top code was $200,000 and coded

as such. The incidence of income top coding was extremely rare. The 1949 survey

lacked information on marital status. Occupational categories refer to the household

head. *White-collar* workers include professionals, technical workers, self-employed, art-

isans, managers, clerical and sales workers. For the 1950 and 1951 surveys, the *high

school* and *college* variables appear to include those who completed some high school or

college, respectively. The codebook is not completely clear. The 1949 survey explicitly

refers to completion of high school and college. Documentation does not specify whether

the *race* variable refers to the respondent or to the household head in the 1950 and 1951

surveys, but it was assumed to refer to the household head.

[6] ***Coding Notes for News Media Survey.*** Respondents top coded at 65 years of age or

over were assigned an age of 70. Those who were top coded as having 9 or more

children were coded as having 9 children, and those who reported having 9 or more group

affiliations were coded as having 9 group affiliations. Respondents were coded as attend-

ing religious services if they reported going to services more than "two or three times per

month" or "regularly." This data set top coded income at "$20,000 or over" which was

converted into $32,000 (which corresponds to $200,000 in 2000 dollars). Occupational

codes are similar to those in the Survey of Consumer Finances. *High School* only

includes those who completed high school.

[7] Hanneymyr (2003) places the inception dates at 1945 (when commercial development

resumed after being suspended during the 2nd World War) for television and at 1989

(when the first commercial ISPs opened their virtual doors) for the Internet.   This

approach is reasonable, but given our focus on long-term diffusion trends, little is lost by

setting the date later. Despite the differing chronology, we concur with Hanneymyr's

main conclusion – that television and the Internet diffused at similar rates.

[8] The results for the unemployed appear anomalous but are explicable as follows: On

average, the unemployed are less likely to connect to the Internet. But they also have a

high incidence of other factors associated with low rates of connectivity – low incomes,

non-white   race,   Hispanic   ethnicity,   rural   residence,   lower   educational   attainment,

residence in the South. Detailed analyses found that unemployment coefficient estimates were sensitive to the inclusion of white-collared workers and students, and income in most years. The unemployed tend to have very low incomes, but may go online more than others with equally low incomes because they have more free time and special incentive to seek work on the Internet. The effect of unemployment also showed some sensitivity to educational levels, but not to race or ethnicity.

[9] A fall 2002 study revealed that well over 90 percent of Princeton University freshman used instant messaging and most preferred it to e-mail or telephones for coordinating activities, as well as for staying in touch with old friends (Schrader 2003).

[10] Because previous studies have shown such high rates of Internet use for Asian-Americans, we subjected this finding to particularly close scrutiny. In every year, Asian-Americans had higher absolute rates of connectivity than Euro-Americans, African-Americans, or Hispanics. But Asian-American CPS respondents also had very high average levels of the strongest predictors of Internet use, including income, white-collar employment, full-time student status, college-degree attainment, non-central metropolitan and western regional residence. Including these variables in the models reduced Asian-Americans' zero-order advantage to the negative coefficients visible in Table 5.

[11] We thank Victor Nee for suggesting this strategy.