

Universal Access and Local Commercial Internet Markets¹

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Abstract: Concern over the potential need to redefine universal service to account for Internet-related services and other combinations of communication and computing motivates this study of the geographic spread of commercial Internet Service Providers (ISPs), the leading suppliers of Internet access in the United States. The paper characterizes the location of 40,000 access points, local phone numbers offered by commercial ISPs, in the Fall of 1997. Markets differ widely in their structure, from competitive to unserved. Over ninety-two percent of the U.S. population has easy access to a competitive commercial Internet access market, while approximately four and one-half percent of the U.S. population has costly access. Urban/rural coverage must be understood in the context of the different strategies of national/local providers.

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I. Motivation

Governments frequently revisit the principle of universal service, making it an enduring issue in communications policy. In past eras this goal motivated policies which subsidized the operation of the telephone network in low-density areas. In recent decades the same concerns motivated policies to eliminate large disparities in the rate of adoption of digital communication technology within the public-switched telephone network (Cherry and Wildman, 1999).

Policy makers in the new information economy face similar issues in a different guise. The burgeoning literature discussing the "digital divide" (see, e.g., National Telecommunications and Information Administration, 1999) has prompted many analysts to anticipate a need to redefine universal service goals to account for Internet-related services.⁴ In fact, these issues are already on the policy agenda. For example, the 1996 Telecommunications Act contains provisions to collect funds to finance the diffusion of Internet access to public institutions, such as schools and libraries. The result is the E-Rate, currently a \$2.25 billion federal program administered by the Federal Communications Commission (FCC). Using revenues generated from charges levied on users of long-distance services, the Universal Service Administrative Company reimburses firms providing telecommunications services, Internet access, and internal connections to eligible schools and libraries.

Researchers and policy makers are, however, concerned with more than the provision of access to public or quasi-public institutions. Specifically, researchers have pondered the role of

⁴A complete bibliography is impossible. For some recent studies, see U.S. Advisory Council on the National Information Infrastructure [1996], National Academy of Engineering [1995], National Telecommunications and Information Administration [1995], Information Infrastructure Task Force [1993, 1994], Drake [1995], Kalil [1995], Kahin [1991], Kahin and Keller [1995], National Research Council [1996], Teske [1995], Compaine and Weinraub [1997], Mueller [1997], and Werbach [1997].

government in closing the "digital divide." Thus, a central question is whether privately motivated firms in the Internet access business achieve some universal service goals as a by-product of their competitive conduct. The contrast with historical issues in telephony helps frame the question. As much scholarship has shown, private firms did develop service over a remarkably large geographic area without government intervention, but economies of density also limited this spread until government subsidies explicitly intervened decades later.³ At the turn of the century low density areas were more expensive to serve than high density areas, so only major cities and nearby towns received telephone service during the era when the technology first diffused. Telephony then spread to isolated and low density areas, with some cities receiving minimal service or none at all.

Will a similar pattern characterize the diffusion of the Internet infrastructure? It is not clear. The Internet has a very unusual genesis (Greenstein [2000]). Unlike telephony, where the technology and commercial business co-evolved, Internet technology incubated under government supervision for over two decades prior to commercialization, making it ripe for immediate diffusion. Also unlike telephony, where the new network developed in opposition to -- and in competition with -- the existing telegraph network, commercial Internet services can be retrofitted onto the existing communications infrastructure. Finally, the Internet is not a fixed technology diffusing across time and space without changing form. Instead, it is a malleable technology, embedded in equipment which employs TCP/IP (Transmission Control Protocol/Internet Protocol) standards. It takes different forms in commercial settings than it did

³This is a large literature. See, for example, Mueller [1997], Barnett [1990], Barnett [1997], and Weiman [2000] about the early telephone industry. The closest analogue to the current paper is Baum, Korn, and Kotha [1995] which examines the population dynamics of facsimile transmission service organizations.

in academic use. Thus, there is little historical precedent for speculating about the present setting. Whether economies of density (or some other factors) will influence the diffusion of the Internet over geographic space remains unclear.³

In this study we examine the geographic spread of commercial Internet Service Providers (ISPs), the leading suppliers of Internet access in the United States. We focus on these suppliers and their conduct for two reasons. First, market-based transactions with ISPs have become the dominant form for delivery of on-line access for medium and small users. In the absence of changes in government policy,⁴ the preeminence of commercial development is now widely forecast to continue. Second, surveys consistently reveal that the US population is far from universal adoption of Internet services at home.⁵ Yet, such surveys beg the question about the availability of access -- in other words, whether all households have access to Internet service at the same low cost.

The first part of this paper provides a framework for thinking about the geographic diffusion of commercially-oriented Internet-access providers. In the long run, ISPs choose where to locate as a strategic matter. One business model relies on a firm structure providing a national service, another relies on a local or regional firm providing local or regional services.⁶ Since all consumers have access to the Internet at some price, the key question for marginal adopters is

³For a summary of this and related debates, as well as an argument in favor of imposing access fees, see Werbach [1997], Garcia and Gorenflo [1997], or Sidek and Spulber [1998].

⁴For example, as of this writing, the Federal Communications Commission does not charge access fees to ISPs, but is considering a number of proposals to do so. See the discussion and request for comment at <http://www.fcc.gov/>.

⁵See, for example, Kridel, Rappaport, and Taylor [1997], Maloff Group International, Inc. [1997], Compaine and Weinraub [1997], or Clemente [1998].

⁶The conclusions from the first part of the paper will be familiar to regular readers of commercial press for the ISP industry. For surveys of the on-line industry and attempts to analyze its commercial potential, see Hoovers [1997], Juliussen and Juliussen [1996], or Maloff Group International, Inc. [1997]. Also, see *Inter@ctive Week* or *Boardwatch*.

whether they can cheaply access the Internet over a telephone line. Because "cheap" is synonymous with a local telephone call to an ISP, the spread of commercial ISPs to low density areas is a useful metric for measuring the availability of commercial Internet to low density areas.

The second half of the paper addresses related empirical issues: Do all regions of the country receive similar access to Internet services provided by commercial firms? How do the different strategic goals of national and local ISPs influence the density of access in different areas? Does the privately financed Internet favor access in some regions over others? To answer these questions the paper then characterizes the location of over 40,000 dial-up access points offered by commercial ISPs in the Fall of 1997. This characterization is the principal novelty of this study.

Fall 1997 was a good time for such a survey. The industry's structure, while not completely stable, had reached a point where it was not changing every month. Most firms had been in the ISP market for a few years, making it possible to document their strategies, behavior and commercial achievement. The key findings of the empirical work are as follows:

- The US commercial ISP market is comprised of thousands of small geographically dispersed local markets for Internet access. There is no single structure that characterizes the ISP market across the country. Nor should we expect this heterogeneity to disappear.
- Over ninety-two percent of the US population had access to a competitive local ISP market. Approximately four and one-half percent of the US population lived in areas with no access to any provider and approximately three percent lived on the margin between easy access and no access.

- Whether there exist significant differences between the experiences of Internet users in urban and rural settings depends on the extent to which national and local firms provide similar services. National firms primarily serve urban areas and compete with regional and local firms there. Local and regional firms primarily serve rural areas and less densely populated areas.

Though our focus is the geographic spread of ISPs, we believe our study will influence many facets of the burgeoning literature on information infrastructure policy. Since ISPs partially use the public-switch network, policy for this network should be sensitive to commercial conduct in the ISP market. In addition, many frontier information technology applications in electronic commerce, such as networking, hosting and large scale web applications, build off the Internet. To the extent that these applications play a more significant role in regional business development, understanding the development of Internet infrastructure also helps us analyze the contribution of new information technologies to regional economic growth. Thus, we finish the paper by drawing implications from our results for ongoing policy debates.

II. Background: The changing nature of Internet access

This study examines the Internet access business in the Fall of 1997, just over five years after the NSF relinquished rights over the Internet to commercial entities. By this time many firms understood the technology for the delivery of Internet access using TCP/IP, but the commercial norms for the business were in flux. Different organizations employed different commercial models for the delivery of Internet access. During this experimentation Internet access spread to most regions of the United States. This study documents and analyzes how far access spread.

Scope of investigation: We analyze the ISP industry after the development of browsers and therefore focus attention on firms that provide dial-up service which enables a user to employ a browser. Browser development occurred at about the same time as the final implementation of policies by the NSF to commercialize the Internet (Greenstein, 2000) and at the same time as the widespread adoption and development of WWW (World-Wide Web) technology. Furthermore, we make no distinction between firms that began as on-line information providers, computer companies, telecommunications carriers, or entrepreneurial ventures. As long as their ultimate focus is commercial Internet access either as a backbone or a downstream provider they will all be characterized as ISPs.

Access and location: Most universal access issues concern the adoption rates of medium and small users, since these are the users on the margin between no-access and a few low-cost alternatives. ISPs targeting users with regular and modest needs, which describes most residential users and small businesses in the United States, require the user to make phone calls to a local switch. The cost of this phone call depends on mostly state regulations defining the local calling area and both state and federal regulations defining the costs of long-distance calling. The presence of ISPs within a local call area, therefore, determines a user's access to cheap Internet service. Similarly, the number of local ISPs determines the density of supply of low-cost access to Internet services within a small geographic region. Thus, the geographic spread of ISPs determines the cost of Internet access for most of the marginal users of the Internet.

As recently as 1995, only a few enterprises offered national dial-up networks with Internet access (*Boardwatch*, 1997), mostly targeting the major urban areas. In contrast, by the Fall of 1997, there were dozens of well-known national networks and scores of less-known national providers. There were also many local providers of Internet access that served as the

links between end-users and the Internet backbone, and local shoestring operations seemed less common.

Government subsidies and the maturing of the ISP industry: Much of this growth of the ISP industry occurred at the same time that explicit government support for the industry was declining. Prior to commercialization of the Internet, government assistance took many forms. The federal government provided subsidies for access to IP networks at remotely situated universities, subsidies for software and shareware development, subsidies for the development of backbone infrastructure, and subsidies for the operation of many governance mechanisms. Nevertheless, the explosive growth of the Internet postdated most of this activity by NSF.

If we provide evidence that commercial firms effectively provide universal access, it might be tempting to interpret our findings as indicating that government involvement in the ISP market had little influence. Such a conclusion would be unwarranted. First, in the mid-1990s the commercial Internet access industry retained significant indirect technical support from university computer science and engineering programs, where federal government research support continued. This support took the form of research grants for the development of new software or hardware and subsidies for the training of advanced engineers. These indirect subsidies undoubtedly influenced the commercial behavior we document below.

Second, the geographic shape of the commercial Internet access market could still retain the imprint of federal and state support for the development of information infrastructure. For example, much backbone was laid in the 1980s and 1990s to support traffic flows between universities and government research facilities or to support other educational needs. Many state governments also developed fiber lines in parts of their state in support of similar initiatives. The firms associated with that backbone, such as MCI, continue to be major providers of backbone

and use much of the backbone for commercial traffic. Commercial developments engendering new traffic patterns altered those configurations in due time, but initially commercial uses were built on top of the old structures. Some part of this infrastructure is attributable to the old subsidies, the costs for this portion of the infrastructure are sunk, and this portion is providing services. Thus, government support for this infrastructure should be properly called a subsidy.

Third, providers may have entered in anticipation of future federal support. Expected support may take many forms. Recent programs, such as the development of Internet II and the E-Rate, have received much publicity. We have no way to tell how much of the observed commercial behavior is attributable to investments made in anticipation of these programs.

Finally, while we focus on the lowest cost sector of the Internet access industry in our study, many firms operating in this sector make provision decisions in conjunction with decisions concerning the provision of other commercial services. Government support influences those other services. Thus, for example, government programs encouraging demand for high-speed access or local infrastructure development may influence the overall profitability of the typical local, regional, or national ISP business in a particular area. As a byproduct, these programs may lead to the development of the dial-up industry in a local area.

The bottom line is that this paper is not an attempt to address the question of whether there should be any government involvement in the ISP market. The data do not permit us to answer this question since, even after commercialization, government policies probably have affected the geographic coverage of access. Instead, our goal is much more limited; to provide evidence about how much or how little commercial ISPs accomplished early in the development of the commercial access market. That might be useful to policy makers seeking to determine if more explicit subsidization of the ISP industry is warranted.

The geographic scope of coverage: This goal requires us not only to summarize the extent of access in particular areas but also to attempt to determine the factors that shape the nature of access in a particular area. As discussed in Greenstein [2000], ISPs make strategic choices over the scale of service to provide at a node, the quality of the hardware and software associated with offering connections, the value-added services to offer in conjunction with access, the geographic scope of their enterprise, and the pricing of their product line. Even current industry surveys demonstrate much heterogeneity in the underlying capital and equipment structures of ISPs, indicative of experimentation in these investments and organizations (Maloff Group International, Inc., 1997, *Boardwatch*, 1997).⁷ All the decisions made by ISPs influence the quality of the service the customers experience (Stapleton, 1997, Maloff Group International, Inc., 1997).

Providers who seek to provide national service must choose the regions in which they maintain POPs (points-of-presence). As we show, most providers with national coverage maintain POPs in any moderately large city in the U.S. in which there is appreciable commercial activity. These commercial motives would lead us to expect to find that national firms cover areas of the U.S. which contain most of the population. Therefore, if the strategic decisions of local and national providers differ systematically, residents of less populated areas may have access to lower quality service, if they have access at all. Thus, in regions with limited access, it is imperative that we document not only the presence of an ISP but the type of ISP that is present. There is incomplete evidence that ISPs located in low density areas are lower quality than those

⁷For example, see the compilation of business lines for ISPs maintained by MecklerMedia on <http://thelist.internet.com/>. Most ISPs offer some dial-up service and many other services.

located in most cities, but further research needs to establish these patterns more definitely (see Strover [1999] or Greenstein [2000]).

III. Research Questions

This discussion predicts that most urban areas will have abundant Internet access from commercial firms and some remote areas might not. Between these two predictions lies a very large set of possibilities. Exploring these possibilities is the focus of the empirical work below.

Question 1 -- The extent of geographic coverage: Some parts of the country will not have access to low-cost commercial Internet providers. It is not in a local or regional or national ISPs interest to provide dial-up service to every small town or less-dense area in the U.S. How much of the population does not have easy access to providers of commercial Internet access? Are those areas overwhelming low-density? How does access change when density increases?

Question 2 -- The degree of competition in urban and rural areas: What conditions characterize the highly competitive areas? We expect most residents of urban and high-density areas will face a competitive and abundant supply of Internet access from commercial firms. How much of the population living in such areas has access to competitive ISP markets?

Question 3 -- Variation in type of provider between urban and rural areas: The provision to rural and low density areas will depend on the entry of local and regional and national firms. No type of firm will predominate in every area. How does the provision of commercial access by local, regional and national firms vary across the U.S.?

IV. Data

In order to track the geographic spread of ISPs, we compiled a list of telephone numbers for dial-up access and their location. We then computed the geographic distribution of the POPs across the U.S. We explain these data and methods below.

A. Data sources

The best way to compile a list of ISPs by location is to go to the information sources used by most potential ISP consumers. In the Fall of 1997, the authors surveyed every compilation of ISPs on the Internet. Only a few of these compilations were found to be comprehensive, systematic, and regularly updated in response to entry and exit. This study's data combine a count of the ISP dial-in list from August/September of 1997 in *thedirectory* and a count of the backbone dial-in list for October of *Boardwatch* magazine.³ This choice was made because *thedirectory*'s ISP list contained the most comprehensive cataloging of the locations of POPs maintained by all ISPs except the national backbone providers, for which *Boardwatch* contains a superior survey of locations.

For many of the tables below, the key question will be the following: How many suppliers have POPs in a county? While answering this question, we came across a few ambiguous situations which we resolved as follows: When the city of a dial-in phone number was listed, we used that.⁴ When it was in doubt, the area code and prefix of the dial-in POP were compared to lists of the locations of local switches with these area-codes and prefixes. We used the location of the local switch in that case. If this failed to locate the POP, which happened for small ISPs that

³Current versions of these lists may be examined at <http://www.thedirectory.org/> and <http://www.boardwatch.com/>. This includes POPs found in the ISP section of *thedirectory* and excludes POPs found in bulletin boards. This also includes POPs for ISPs listed in the *Boardwatch* backbone section.

⁴When a city is part of two counties and the phone number did not resolve the ambiguity, the phone number was counted as part of the county in which the city has the greatest share of its land.

only provide information about their office and nothing about the size of their dial-up network, then the voice dial-in number for the ISP was used as an indicator of location.¹⁰

On final count, *thedirectory* contained 34,885 phone numbers not found in *Boardwatch*, *Boardwatch* contained 4,005 phone numbers in its backbone list not found in *thedirectory*, and 984 phone numbers came from both. The merged set contained 39,874 phone numbers which serve as dial-in POPs. Applying the above procedures and principles resulted in a total of 31,163 unique firm/county presences for 4,976 ISPs. Of these firm/county presences, over three quarters were associated with just over two hundred firms. Of the total number of ISPs, approximately half were ISPs for which we had only a single phone number.

This procedure will produce flawed data for our purposes only if it generates sampling error which correlates with geography. We think not, though the above procedures may have imparted some small biases to some counties, which we describe below. Overall, there appears to be no strong evidence of any error in the coverage of small commercial ISPs. In addition, there appears to be a strong positive correlation in the geographic coverage of national firms because most of them locate predominantly in urban areas. Thus, even if these two lists failed to completely describe the coverage of many national firms, it is unlikely that the qualitative conclusions below would change much if the omitted POPs of these firms were added.¹¹

The above procedures may show less ISP entry than has actually occurred in new suburbs in counties that border on dense, urban counties, since new, growing suburbs frequently use the

¹⁰This last procedure mostly resulted in an increase in the number of firms we cover, but not a substantial change in the geographic scope of the coverage of ISPs. The data set contained over 37,000 phone numbers prior to adding firms that only provided a phone number for their home office. The additional 2,500 phone numbers did not disproportionately show up in uncovered areas. They did, however, help identify entry of ISPs in a few small rural areas.

¹¹As a check, we determined that, even if a dozen national providers were left out of the sample, the basic qualitative conclusions would not change.

telephone exchange of existing cities. Unless the ISP specifically names this new suburb in the bordering county as a targeted area, our procedures will not count the ISP's presence in that new suburb.¹² We will control for this potential bias below through tables that treat as the market a county and its nearby neighbors.

B. Definitions

Both *thedirectory* and *Boardwatch* try to distinguish between bulletin boards and ISPs, where the former may consist of a server and modems, while the latter provide WWW access, FTP, e-mail, and often much more.¹³ We exclude firms the primary business of which is providing downloadable text or software without Internet access and firms that only provide direct access and not any dial-up service.

Both lists concentrate on the for-profit commercial sector.¹⁴ For example, both eschew listing university enterprises that effectively act as ISPs for students and faculty. This is less worrisome than it seems, since commercial ISPs provided over 90 percent of household access within a few years (Clemente, 1998). In addition, commercial ISPs gravitate towards the same locations as universities. This study's procedure, therefore, will likely pick up the presence of ISP access at remotely situated educational institutions unless the amount of traffic outside the university is too small to induce commercial entry.

¹²A similar and related bias arises when a county's boundaries and a city's boundaries are roughly equivalent, even when the neighboring county contains part of the suburbs of the city. In this situation, many ISPs will claim to be located within the city's boundary even though residents will recognize that the ISP is located on the city boundary and its coverage may be more extensive than this declaration would indicate.

¹³Extensive double-checking verified that *thedirectory* and *Boardwatch* were careful about the distinction between an ISP and a bulletin board. No bulletin boards were ISPs, and they were appropriately not classified as an ISP.

¹⁴*The directory* does, however, list some free-nets. Their inclusion appears to depend on whether the free-net notifies *thedirectory* of their existence, seeking users from the general population.

In all tables below, national ISPs are defined as firms that maintain POPs in more than 25 states. This is slightly more stringent than the definition for national provider found in *Boardwatch*, in which the definition of national is any provider in more than 25 area codes, but in practice it is not much different. Local firms are present in three or fewer counties. The remainder are considered regional ISPs.

The tables below provide a broad description of county features. Population numbers come from 1996 U.S. Bureau of the Census estimates. We label a county as urban when the Census Bureau gives it an MSA designation, which is the broadest indicator of an urban settlement in the region and includes about a quarter of the counties in the U.S.

For all tables below, the data pertain to all states in the U.S. except Alaska and Hawaii.¹⁵ These data also include the District of Columbia, which is treated as another county. Throughout this study county definitions correspond to standard U.S. Census county definitions. This results in a total of 3110 counties.

To cope with the fact that county boundaries are political boundaries and do not directly correspond with meaningful economic market boundaries, we calculate summary statistics in two ways, one which does not account for nearby counties and one which does.¹⁶ We label the calculations without nearby counties as "County of residence," which means that we are treating each of the 3110 counties as a separate observation. All reported statistics are about each county and only about each county. For the second set of calculations, where we wish to learn about a county and the nearby area, we make tables for a "County of residence and all counties within 30

¹⁵Alaska is excluded because its geography and related statistics are so unusual. Due to a research assistant's error, data for Hawaii were found to be flawed and thus had to be omitted.

¹⁶To do this we use the U.S. Bureau of the Census's CONTIGUOUS COUNTY FILE, 1991: UNITED STATES.

miles." By this we mean that each of the 3110 counties is the elemental observation, but that in calculating some of the summary statistics we use as the unit of observation the county together with some of the nearby neighboring counties. We define "nearby" counties as counties with a geographic center, as defined by the U.S. Bureau of the Census, within 30 miles of the geographic center of the county of residence. We chose 30 miles because this is within the first mileage band for a long distance call in most rural areas.¹⁷

C. Maps

Figure 1 illustrates the density of location of ISPs across the U.S. at the county level. Black areas are counties with more than three providers. Gray areas have between one and three. White areas have none. The picture illustrates the uneven geographic coverage of the ISP industry. ISPs tend to locate in all the major population centers, but there is also plenty of entry into rural areas. The map also illustrates the importance of accounting for the influence of nearby counties.

V. The geographic scope of ISPs in Fall 1997

The summary of the nature of ISP coverage can be found in Tables 1 through 4. Each Table contains two parts, one based on each of the methods described above.

¹⁷We experimented with a number of different mileage bands. We tried 15 miles and found that the results were qualitatively no different from using no information about county neighbors. We also tried the other extreme, calculating the influence of all neighboring counties without distinguishing by their distance but found that this was far too inclusive of neighboring counties the populations of which could not be linked by local phone calls. These latter results are included in the appendix for the curious reader.

Table 1a shows the number of counties with ISPs numbering zero or one or two or so on, the percentage of the U.S. population that lives in those counties, the cumulative population percentage, and the percentage of those counties that are urban counties.

Of the 3110 counties, 1108 do not contain a single POP supported by any ISP, 719 have only one, and 328 have two. Not surprisingly, a small fraction of the population resides in these counties. Just under a fifth of the U.S. population lives in counties with three or fewer ISPs. As further evidence that low (high) entry is predominantly a rural (urban) phenomenon, there is an inverse relationship between the percentage of counties that are rural and the number of suppliers who enter.

Table 1a seems to suggest that, in the Fall of 1997, approximately a fifth of the U.S. population lived in counties with three or fewer suppliers, which would seem to be an inadequately competitive supply of commercial Internet access. Of this subset of the population, over a third had no ISP at all in their county. This is a hasty conclusion, and, as shown below, too pessimistic.

First, this interpretation of Table 1a is too pessimistic because the results actually reveal that commercial forces have spread Internet access to a substantial part of the U.S. population. Compared with some of the most pivotal networking industries in the last two centuries, such as electricity, communications, rail, and broadcasting, this diffusion is remarkably rapid.

More to the point, the table does not provide a summary of the percentage of U.S. population that has easy access to commercial ISPs. It understates the true level of access because it does not account for the U.S. population living in counties with very few suppliers that, nonetheless, border on competitive markets. Similarly, it overstates access in counties in which the suppliers are predominantly in one area, such as within a central city, while some part of the

population resides in other areas of the county, such as far outside the central city, separated by a long distance phone call.

Like Table 1a, Table 1b is organized by counties in the continental U.S., where the central county is the unit of observation. It shows the number of counties with ISPs numbering zero or one or two or so on in the county or nearby neighboring counties, the percentage of the U.S. population that lives in those central counties, the cumulative population percentage, and the percentage of the central counties that are urban counties.

Of the 3110 counties, 321 do not contain a single POP supported by any ISP in its county or in any nearby county, 185 have only one, 217 have only two, and 140 have only three. Once again, these counties tend to contain a small part of the population. Just under four and one-half percent of the U.S. population lives in counties with three or fewer ISPs nearby. As further evidence that low (high) entry is predominantly a rural (urban) phenomenon, almost ninety-five percent (1447 out of 1526) of the counties with ten or fewer suppliers are rural.

Table 1b offers the starkest finding of this study. More than 92 percent of the U.S. population has access by a short local phone call to seven or more ISPs. Moreover, the geography of the universal access issue, as of the Fall of 1997, was predominantly rural and, then, only pertinent to a fraction of the rural population.

Tables 2a and 2b elaborate on Tables 1a and 1b, giving the relationship between the presence of ISPs and some basic features of counties, principally population and population density. While there is variance around the relationship between population and the presence of ISPs, the trend in average population size is almost monotonic. That is, for small markets the number of suppliers grows with population. This result holds whether the market definition

accounts for neighboring counties or does not. Density is also correlated with entry, a result that is more apparent when one accounts for neighboring counties.

Tables 3a and 3b explores the difference between urban and rural areas, shedding light on the relationship of density to entry. It breaks the counties into those in urban and those in rural areas, then computes the same summary statistics as in Table 2. The most obvious feature is that population levels and densities differ between urban and rural areas. More important, there is also a difference in the relationship between the population and density of the region and ISP entry. In rural areas, both population levels and population density predict the level of entry into counties with fewer than four suppliers. In contrast, in urban areas population levels do not strongly coincide with ISP entry. Since there are, however, so few urban area observations with ten or fewer ISPs in Table 3b, these results may be strongly driven by a few observations.

A comparison of Tables 3a and 3b tells us that controlling for the neighboring counties makes a big difference to the quality of inference about the relationship between county and ISP entry. Virtually every single urban county without any ISPs is located next to an urban county with ISP entry. Often, there is extensive ISP entry next door.

Finally, Table 3b is consistent with the view that there are economies of scale at the POP and these economies largely determine the relationship between number of suppliers and population levels in rural areas. If there are economies of scale at the POP and no difference in demand across regions with different density, then economies of scale determine threshold entry and incremental entry thereafter. Table 3b is not conclusive evidence of these scale economies, however, because it does not control for levels of demand. It is possible that different geographic features of these areas may correlate with different levels of demand or unobserved intensities of demand that systematically differ across counties of different population size. There

is insufficient evidence in these tables to test these competing hypotheses. To do so would require careful measurement of the determinants of demand (see Kridel, Rappaport, and Taylor [1997]).

Tables 4a and 4b present the structure of ISP entry in small markets. It divides markets by the number of entrants and then classifies them into those in which all suppliers are either local, regional or national. The striking feature of both tables is that many small markets are entirely supplied by local or regional ISPs. Rarely, if ever, are any of these small markets entirely supplied by national ISPs. In fact, of the 3110 counties in the data set, 2482 counties have no national ISP, 1608 counties have no regional ISP, and 1768 ISPs have no local ISP.¹³ As can be seen in Table 4a, of the 719 counties with only one supplier, 280 have a local ISP, 425 have a regional ISP, and 14 have a national ISP. In 317 counties with two suppliers, 78 have only local ISPs, 99 have only regional ISPs, and 6 have only national ISPs.

Even if we consider the expanded market definition, national providers are absent from many markets. Of the 3110 counties in our data set, 1550 counties are not within 30 miles of a national provider, 700 are not within 30 miles of a regional provider and 730 are not within 30 miles of a local ISP. Table 4b gives more information on the types of providers in markets with few entrants. Of the 185 with only one supplier in this county and nearby counties, 75 are served by a local ISP, 107 are served by a regional ISP, and 3 are served by a national ISP. Of the 225 with two suppliers in this county and nearby counties, 52 have only local suppliers, 131 have only regional, and 3 have only national. Further, Table 4b shows that once the number of entrants gets past about five or six in a county and nearby area, then the residents will likely have a choice

¹³These are not mutually exclusive. Many of the counties without a local ISP are the same counties without a regional or national ISP.

among a mix of national, local and regional suppliers. This is striking evidence that national and local ISPs treat urban and rural areas differently.

The other columns of Table 4b show the population that lives in the counties with only one type of supplier. Just under 5.75 million people live in counties with only local ISPs. Just over 5.25 million live in counties with only regional suppliers. Just over 0.1 million live in counties with only national providers. Further, about 11.99 percent of the population resides in counties in which no national ISP is present in the market. These figures provide a cautionary note to accompany the interpretation above of Table 1. If national, regional and local firms provide different quality of service, and if the national firms are better, then Table 4b is evidence that the presence of an ISP may not be sufficient to infer similar access in both urban and rural areas. That said, this is primarily an issue for small rural counties.

To illustrate these points, we provide Figure 2, which shows all the counties with at least one national provider. Counties shaded in black have at least one national provider, and counties shaded in gray have only local or regional providers. The figure shows clearly that national firms are present primarily in the major urban areas. In the areas with the least entry, predominantly rural counties, no national firm has entered. Indeed, Figures 1 and 2 look similar for this reason.

A majority of ISPs specialize in either urban or rural areas. All things equal, most ISPs have a foot in an urban county. Indeed, most local ISPs are located in thick competitive urban markets, which gives them a very different experience from the local ISPs in thin rural markets. Very few local ISPs specialize in only rural counties. This is consistent with the view that ISPs that grow in geographic scope tend to go into neighboring geographic counties with different characteristics. Even if they began in an urban county, they expand to provide service in rural

areas, and vice versa. The greater the geographic spread of the ISP; the more likely it will be in a mix of urban and rural counties.

National firms tend to target the same regions. Virtually all of the national firms have a presence in the same large U.S. cities. As a result, three quarters or more of the population of the U.S. have access to very competitive service from a variety of national and local firms. If a county is large enough to support over six suppliers the population is almost certain to have access to a variety of entrants -- local, regional and national. Since almost 92 percent of the population has access to markets with seven or more suppliers, we conclude that no less than 92 percent of the U.S. population has access to the full range of firms found in a competitive access market.

This suggests that it may be appropriate to expand the view of the market structure of ISPs. As a rough approximation to understanding strategy and structure, firms in the ISP access industry could be classified into five categories: 1. *Urban/national*: National firms that predominantly specialize in urban areas and secondarily serve rural areas. This is the vast majority of national firms. 2. *Urban/local*: Local firms that predominantly specialize in urban areas. This is a substantial majority of local firms. 3. *Rural/local*: Local firms that predominantly specialize in rural areas or small towns. While not the majority of local firms, these still number in the hundreds. These are the majority of firms to be found in rural areas. 4. *Rural/national*: National firms that predominantly specialize in rural areas and secondarily in urban areas. This is a handful of firms. 5. *Regional*: Firms that have as their base either a single rural or urban market but that also have a geographic territory expanding beyond that base. These number over a hundred.

This taxonomy is consistent with the framework in the first half of the paper. Firms differ in their strategy, in their location, and the degree of competitiveness of the markets they enter, but they largely choose among a small number of organizational forms in equilibrium. Most firms will be either high-quality national ISPs or high-quality local ISPs, firms in categories 1 and 2. The analysis correctly suggested that categories 3, 4 and 5 would not represent the experience of the majority of firms. If the analysis is correct, these latter three categories will become even less common over time. In particular, category 5, regional ISPs, may become temporarily important and then diminish in number as many local firms expand beyond their initial geographic reach on the way to becoming national.

Two different interpretations are consistent with the pattern in Table 4 and Figure 2. If one believes that national ISPs offer higher quality access than local ISPs, then the economies of scale required to maintain high-quality POPs will preclude national entry in small markets. On the other hand, if one considers local or regional ISPs to be better than national ISPs at tailoring their services to the unique needs of their area, then national ISPs will acknowledge their disadvantage and often choose not to enter. Notice too that this second view requires there to be something unique or idiosyncratic about the tailoring of services to small local markets. Otherwise, national firms could easily imitate the strategies pursued by local or regional firms in small markets. Several dozen national firms are present in hundreds of locations, providing access to many users, while the majority of firms are not.

In the absence of some decreasing cost technology, such as some sort of coordination economies, or increasing returns on the demand-side, these basic economics limit the geographic expansion of the national ISP networks. Since national firms also face economies of scale at the POP -- even at a remotely monitored POP -- and constant costs to the addition of POPs, it follows

that they too find it unprofitable to be ubiquitous. It will not be beneficial for any national firm to expand its network POPs in increasingly remote areas, bringing in fewer additional customers with each additional expansion. It is better for MCI or AT&T, for example, to offer potential customers in remote locations 800 service or direct access lines if the user is a business.

VI Implications

Five findings from these tables should shape further policy discussions of the commercialization of Internet access. First, the diffusion of Internet access is a commercial process, driven by commercial motives. As such, the firms in this industry have developed Internet access markets for most of the U.S. population in a relatively short period. Second, some regions of the country, primarily less densely populated rural areas, do not have access to any low cost commercial Internet providers. There is a minimum threshold of population needed to support entry of an ISP POP. It seems possible that local and national POPs face different thresholds. Third, some regions face competitive access markets and some do not. Most residents of urban and high-density areas face a competitive and a abundant supply of Internet access from commercial firms. The part of the U.S. population which does not have access to a competitive ISP market lives in rural and low-density areas. Fourth, no single type of market structure is ubiquitous. Marginal rural areas are mostly covered, if covered at all, by local or regional ISPs. In urban areas, virtually all markets contain a mix of local and national ISPs. Fifth, it appears that local and national firms pursue different entry strategies. These translate into different geographic scope for local and national firms in the industry. We develop a few additional implications of these facts below.

The scale of ISPs and scope of geographic coverage: The results in Tables 4a and 4b are consistent with the view that small areas or rural areas are first being developed by local and regional ISPs and only occasionally by national ISPs. This may mean that, in many of these areas with fewer providers, the quality of service is low. In fact, many trade publications predict that low-quality dial-up service can survive only in rural areas or isolated markets.

It is inappropriate, however, to assume that local ISPs provide lower quality service. For example, in areas in which national firms have a presence, the high-quality ISP could still thrive if it targets users who do not want AOL's brand of service or AT&T's lack of hand-holding, but doing so may be expensive, necessitating a minimum scale of service (Stark, 1997). Because the underlying engineering capabilities have diffused so widely, the local firm must provide a service that includes features which will not be imitated by fast-second entry from a national firm. For example, many features of Internet commerce, such as web-page design, have quickly become standardized, giving advantages to low-cost national designers, but local firms may be able to reflect local needs. Local firms may also develop reputations for quicker service in emergencies, friendlier site visitation or user-instruction, and customized technical support.

In sum, the different population thresholds for local and national POPs are consistent with three theories. First, local POPs in rural areas may enter with lower quality than national POPs. That is, entering with low-quality equipment lowers a local POPs costs. Alternatively, local POPs in rural areas may be entering with different value-added services than national POPs in urban areas. That is, local POPs in rural areas may not be deriving much profit from their ISP service, but make up for these losses with other complementary services tailored to rural areas.¹⁹ The second view only makes sense if the value-added services offered by a local POP have a

¹⁹For some data on these hypotheses, see Strover [1999] or Greenstein [2000].

strong local component; otherwise, a national firm could imitate it and profitably expand into rural areas. A third view²⁰ is that many rural ISPs provide service as part of their activities as rural cooperatives or other quasi-public institutions supporting local growth. In this view profit motives are not the key driver of entry in rural areas, but rather community and public service. This different motive would account for the willingness of rural ISPs to enter areas that profit-oriented, national ISPs avoid. It is still largely a matter of speculation about which view is most likely.

These three views will set the agenda for the universal access debate into the next century. If there are strong economies of scale at the POP, these will limit entry of ISPs in rural and remote areas. If ISPs become essential for local growth, there may be a role for public or quasi-public local institutions to subsidize local ISPs to overcome their inability to take advantage of these scale economies. If the local component of an ISP's service becomes an essential element of its offerings, then national firms may never find it commercially profitable to move to remote areas. If high quality service is expensive to offer, then remotely situated firms in rural areas may find it difficult to afford to upgrade their networks. And, of course, all of this could change if scale economies weaken or if the costs between high and low quality narrow enough so that ISP product lines become similar in rural and urban areas.

Market structure, taxation and subsidies: These patterns should influence any debate about subsidies and taxation of the ISP industry. All future policy debates should be cognizant of the fact that changes in policy will affect urban and rural areas differently. For example, altering access charges for ISPs will elicit different responses depending on whether the area is predominantly served by local or national companies. Similarly, taxing ISPs, which many states

²⁰See, in particular, Garcia [1996] and Garcia and Gorenflo [1997].

are already doing or proposing to do, will produce similar differences in urban and rural communities. These points are especially true if the business model for ISPs -- particularly the percent of revenue associated with non-dial-up business -- differs between urban and rural areas; in that case, the same tax could result in altering the mix of services offered in each type of area.

Proposals for subsidizing ISPs also bring forth some difficult questions. First, the results above make clear that few residents of the U.S. have no access to the Internet. Thus, universal subsidies to ISPs in urban areas and other competitive markets seem unjustifiable. Second, if private firms stay out of rural areas they do so for sound economic reasons. Only compelling social benefits justify ignoring these reasons. Some critics charge that ISPs are already receiving a large implicit subsidy by not paying for access.²⁴ Are the social benefits of extending ISPs further subsidies, even if those subsidies are targeted, worth an increase in these social expenses?

Finally, a series of related and still unsettled questions concern the implications of the unobserved strategies of the five types of firms. Do value-added services, pricing, and quality differ by geography? If so, is this problematic for policies of universal access? Do rural/local and urban/local firms differ substantially in quality? If so, could, and should, any government body do anything about it? Will rural markets be served only by rural/local or regional firms and never have access to the features provided by urban/local or urban/national firms? If some types of commercial firms locate in certain places but not others in a complex pursuit of profits, could a government change this through subsidies and other mandates? These are not simple questions. These are the types of questions that ISP policy needs to address so as to make headway on resolving the universal service debate in Internet technologies.

²⁴For example, contrast the very different proposals in Sidek and Spulber [1998] and in Garcia and Gorenflo [1997]. The former call for an end to implicit subsidies, and the latter comes close to calling for subsidies for rural ISP service.

Future consolidation and universal access: It is common in the business trade press to predict consolidation of ownership of the ISP industry. On one level, this study suggests that this belief has no economic basis. Multiple firms survive in this industry, and some appear to have a strong local component, which would suggest little scope for national consolidation of all firms. On the other hand, many firms have national networks and are trying strategies in which national branding plays a large role. If those national brand names begin to take on value, either because they stand in for higher quality, more reliability, or some other difference in service that cannot be imitated by a local firm, then consolidation will occur.

There appears to be much room for consolidation within this industry. There are scores of national providers and thousands of local ISPs. The ISP access market could experience hundreds of mergers in ISPs or alliances between sets of ISPs and not come close to violating any potential antitrust statute. Nor would many potential consolidations of ISP firms excessively concentrate access in too few hands.²³ That said, as of Fall 1997, there is an important local component to the industry. Consolidations that do not concentrate market share at the national level may concentrate access in a local market.

Consolidation will not influence access in rural areas if local ISPs continue to be the predominant provider of access in remote regions. However, if national and local ISPs begin to

²³Two caveats apply to this observation. First, as has been noted by other authors (McKnight and Bailey [1997] and several articles therein, such as Srinagesh [1997]), there are potential bottlenecks in many facets of the backbone of the network. Concentrated ownership of these bottlenecks could have consequences for market power in this industry. The text only pertains to the downstream industry. Second, these numbers only speak to concentration in POPs, not market share. By some estimates the AOL/CompuServe merger gives one firm somewhere between 40% and 50% of the residential access market (Maloff, 1997). It is an open issue whether the alternative POPs discipline AOL's pricing (*The Economist*, 1997).

diverge in quality over time, and if the industry does not remain as fragmented as it is today, the concentration of the industry could raise issues over universal access to high quality services.

VI. Conclusions

The commercial Internet access industry has an important geographic component which correlates with features of market structure, quality of service, pricing and competitiveness. As a result, most of the important issues in the universal access debate also have an important geographic component. The links between geographic coverage and market structure arise because an ISP, whether it is national, regional or local, simultaneously chooses several important dimensions of firm strategy, including the geographic coverage of the firm. These choices involve many tradeoffs between the costs of providing a service, the strategies of the firm for growth, and the revenues generated by those decisions.

The location pattern we observe in the Fall of 1997, particularly the failure of ISP service to spread to all parts of the country, is consistent with the existence of economies of scale at the POP. Related strategic decisions induced variance in market structure in different regions of the country. The end result is that most of the population faces competitive supply of Internet access, while the remainder faced less ideal conditions in some rural areas.

These structural and strategic differences should be central issues in policy discussions of universal access to advanced communications and computing technology. Many issues will remain unresolved until future research on access analyzes the precise determinants of firm entry and expansion strategies. How important is the presence of a wealthy or educated population? How important is the presence of advanced telecommunications infrastructure or a major

educational institution? The answers to these questions are the key to understanding different patterns in different regions. Thus, these answers are the key to properly structuring policies.

Finally, these patterns are remarkable in historical perspective. Universal service in telephony took decades to achieve, and only after considerable policy wrangling over subsidies for rural telephony and over policies for interconnecting rural telephone companies with the dominant long-distance firm, AT&T. In contrast, ISPs retrofit their businesses onto the existing public switch network with relatively low transaction costs in most places, enabling a small scale provider to succeed in low density areas. Also, unlike telephony, the ISP industry did not require an entirely new equipment industry; instead, it relied primarily on existing equipment suppliers in PC markets, the established computer bulletin board market and local area network markets. Such qualifications require further understanding, since it is not as obvious that these conditions will persist into the future. Hence, the fast and pervasive diffusion of dial-up access may not serve as an example for the diffusion of the next generation of commercial broadband Internet access.

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Table 1a
Entry of ISPs: Number of Providers in the "Market"

| Market Definition: County of Residence Only | | | | |
|--|---------------------------------------|---|---|--|
| Number of Providers in Market | Number of Counties¹ | Percentage of Population in These Counties | Cumulative Population Percentage | Percent of These Counties Urban |
| 0 | 1,108 | 7.19 | 100.00 | 13.27 |
| 1 | 719 | 6.88 | 92.81 | 11.82 |
| 2 | 328 | 4.55 | 85.93 | 17.38 |
| 3 | 168 | 3.16 | 81.39 | 19.64 |
| 4 | 94 | 2.16 | 78.23 | 24.47 |
| 5 | 63 | 1.61 | 76.07 | 30.16 |
| 6 | 44 | 1.25 | 74.46 | 38.64 |
| 7 | 22 | 0.83 | 73.21 | 50.00 |
| 8 | 33 | 1.56 | 72.37 | 39.39 |
| 9 | 22 | 0.78 | 70.81 | 50.00 |
| 10 | 27 | 1.02 | 70.03 | 33.33 |
| 11-15 | 86 | 4.93 | 69.02 | 56.98 |
| 16-20 | 42 | 2.26 | 64.09 | 69.05 |
| 21 or more | 354 | 61.83 | 61.83 | 94.92 |

Table 1b

| Market Definition: County of Residence and All Counties Within 30 Miles | | | | |
|--|---------------------------------------|---|---|--|
| Number of Providers in Market | Number of Counties[†] | Percentage of Population in These Counties | Cumulative Population Percentage | Percent of These Counties Urban |
| 0 | 321 | 1.23 | 100.00 | 1.56 |
| 1 | 185 | 0.89 | 98.77 | 6.49 |
| 2 | 217 | 1.36 | 97.88 | 5.07 |
| 3 | 140 | 0.93 | 96.52 | 5.00 |
| 4 | 163 | 1.36 | 95.59 | 4.29 |
| 5 | 105 | 0.90 | 94.23 | 4.76 |
| 6 | 105 | 1.08 | 93.33 | 7.62 |
| 7 | 64 | 0.65 | 92.26 | 7.81 |
| 8 | 81 | 1.16 | 91.61 | 9.88 |
| 9 | 67 | 0.62 | 90.45 | 4.48 |
| 10 | 78 | 0.80 | 89.83 | 10.26 |
| 11-15 | 223 | 2.58 | 89.02 | 10.31 |
| 16-20 | 153 | 2.03 | 86.44 | 10.46 |
| 21 or more | 1,208 | 84.41 | 84.41 | 59.69 |

Note: 1) For the calculations in the final three columns, the county of residence is treated as the unit of observation.

Table 2a
Population and Population Density by Number of Providers in the "Market"

| Market Definition: County of Residence Only | | | | | |
|--|---------------------------|-------------------------------|---------------------------------|---|---|
| Number of Providers in Market | Number of Counties | Mean Population-County | Mean Population - Market | Mean Pop. Density[†] - County | Mean Pop. Density[†] - Market |
| 0 | 1,108 | 17,087.14 | 17,087.14 | 49.73 | 49.73 |
| 1 | 719 | 25,222.47 | 25,222.47 | 105.26 | 105.26 |
| 2 | 328 | 36,520.12 | 36,520.12 | 77.99 | 77.99 |
| 3 | 168 | 49,503.27 | 49,503.27 | 102.88 | 102.88 |
| 4 | 94 | 60,560.44 | 60,560.44 | 165.36 | 165.36 |
| 5 | 63 | 67,341.00 | 67,341.00 | 220.98 | 220.98 |
| 6 | 44 | 75,109.66 | 75,109.66 | 131.07 | 131.07 |
| 7 | 22 | 99,532.45 | 99,532.45 | 477.43 | 477.43 |
| 8 | 33 | 124,554.45 | 124,554.45 | 356.76 | 356.76 |
| 9 | 22 | 93,672.55 | 93,672.55 | 226.64 | 226.64 |
| 10 | 27 | 99,084.30 | 99,084.30 | 205.42 | 205.42 |
| 11-15 | 86 | 151,045.00 | 151,045.00 | 672.71 | 672.71 |
| 16-20 | 42 | 141,591.69 | 141,591.69 | 282.24 | 282.24 |
| 21 or more | 354 | 460,219.22 | 460,219.22 | 1,158.46 | 1,158.46 |

Table 2b

| Market Definition: County of Residence and All Counties Within 30 Miles | | | | | |
|--|---------------------------|-------------------------------|---------------------------------|---|---|
| Number of Providers in Market | Number of Counties | Mean Population-County | Mean Population - Market | Mean Pop. Density¹ - County | Mean Pop. Density¹ - Market |
| 0 | 321 | 10,064.06 | 33,804.18 | 10.80 | 11.42 |
| 1 | 185 | 12,725.99 | 68,626.23 | 25.97 | 22.30 |
| 2 | 217 | 16,540.54 | 66,266.03 | 19.58 | 20.44 |
| 3 | 140 | 17,464.39 | 102,187.50 | 28.84 | 33.47 |
| 4 | 163 | 21,922.39 | 93,960.31 | 27.14 | 28.81 |
| 5 | 105 | 22,600.97 | 132,260.24 | 46.25 | 44.06 |
| 6 | 105 | 27,043.89 | 119,064.46 | 58.39 | 39.07 |
| 7 | 64 | 26,791.59 | 160,714.14 | 45.44 | 50.48 |
| 8 | 81 | 37,680.80 | 175,331.12 | 67.18 | 57.98 |
| 9 | 67 | 24,340.34 | 169,103.97 | 48.47 | 54.99 |
| 10 | 78 | 27,170.12 | 175,260.94 | 49.01 | 57.35 |
| 11-15 | 223 | 30,527.13 | 199,563.45 | 61.48 | 66.04 |
| 16-20 | 153 | 34,998.62 | 221,015.17 | 73.00 | 73.86 |
| 21 or more | 1,208 | 184,113.07 | 994,489.46 | 537.43 | 345.43 |

Note: 1) Population density is measured as population per square mile.

Table 3a
 Population and Population Density by Number of Providers in the "Market" and by Urban/Rural Status

| Market Definition: County of Residence Only | | | | | |
|---|--------------------|---------------------|---------------------|------------------------------------|------------------------------------|
| Number of Providers | Number of Counties | Mean Pop. in County | Mean Pop. in Market | Mean Density ^d - County | Mean Density ^d - Market |
| Rural Counties | | | | | |
| 0 | 961 | 12,675.03 | 12,675.03 | 26.41 | 26.41 |
| 1 | 634 | 19,689.31 | 19,689.31 | 46.22 | 46.22 |
| 2 | 271 | 29,714.10 | 29,714.10 | 61.31 | 61.31 |
| 3 | 135 | 37,272.80 | 37,272.80 | 76.79 | 76.79 |
| 4 | 71 | 41,848.39 | 41,848.39 | 62.59 | 62.59 |
| 5 | 44 | 46,389.48 | 46,389.48 | 114.29 | 114.29 |
| 6 | 27 | 50,322.81 | 50,322.81 | 69.15 | 69.15 |
| 7 | 11 | 50,825.91 | 50,825.91 | 56.57 | 56.57 |
| 8 | 20 | 62,526.10 | 62,526.10 | 153.34 | 153.34 |
| 9 | 11 | 75,006.18 | 75,006.18 | 124.13 | 124.13 |
| 10 | 18 | 53,953.72 | 53,953.72 | 50.14 | 50.14 |
| 11-15 | 37 | 75,147.14 | 75,147.14 | 90.96 | 90.96 |
| 16-20 | 13 | 85,917.77 | 85,917.77 | 153.69 | 153.69 |
| 21 or more | 18 | 71,063.33 | 71,063.33 | 217.27 | 217.27 |
| Urban Counties | | | | | |
| 0 | 147 | 45,930.90 | 45,930.90 | 202.19 | 202.19 |
| 1 | 85 | 66,493.33 | 66,493.33 | 545.65 | 545.65 |
| 2 | 57 | 68,878.54 | 68,878.54 | 157.25 | 157.25 |
| 3 | 33 | 99,537.03 | 99,537.03 | 209.65 | 209.65 |
| 4 | 23 | 118,323.70 | 118,323.70 | 482.58 | 482.58 |
| 5 | 19 | 115,860.32 | 115,860.32 | 468.05 | 468.05 |
| 6 | 17 | 114,477.00 | 114,477.00 | 229.40 | 229.40 |
| 7 | 11 | 148,239.00 | 148,239.00 | 898.30 | 898.30 |
| 8 | 13 | 219,982.69 | 219,982.69 | 669.73 | 669.73 |
| 9 | 11 | 112,338.91 | 112,338.91 | 329.14 | 329.14 |
| 10 | 9 | 189,345.44 | 189,345.44 | 515.97 | 515.97 |
| 11-15 | 49 | 208,355.63 | 208,355.63 | 1,111.99 | 1,111.99 |
| 16-20 | 29 | 166,548.97 | 166,548.97 | 339.86 | 339.86 |
| 21 or more | 336 | 481,066.86 | 481,066.86 | 1,208.88 | 1,208.88 |

Table 3b

| Market Definition: County of Residence and All Counties Within 30 Miles | | | | | |
|---|--------------------|--------------------|--------------------|------------------------------------|------------------------------------|
| Number of Providers | Number of Counties | Mean Pop. - County | Mean Pop. - Market | Mean Density ¹ - County | Mean Density ¹ - Market |
| Rural Counties | | | | | |
| 0 | 316 | 9,359.06 | 32,454.62 | 9.88 | 10.61 |
| 1 | 173 | 10,353.55 | 59,610.71 | 22.80 | 19.05 |
| 2 | 206 | 14,850.00 | 62,042.55 | 17.23 | 18.71 |
| 3 | 133 | 15,647.26 | 96,563.68 | 26.01 | 31.06 |
| 4 | 156 | 21,332.12 | 90,519.33 | 26.07 | 27.71 |
| 5 | 100 | 20,640.26 | 125,920.29 | 43.78 | 42.05 |
| 6 | 97 | 23,113.07 | 110,440.44 | 55.95 | 36.23 |
| 7 | 59 | 25,111.17 | 148,928.73 | 41.42 | 46.57 |
| 8 | 73 | 30,423.42 | 149,874.45 | 60.80 | 46.35 |
| 9 | 64 | 22,465.92 | 160,580.81 | 46.00 | 51.93 |
| 10 | 70 | 25,769.84 | 150,005.03 | 42.62 | 47.57 |
| 11-15 | 200 | 27,416.96 | 183,663.62 | 55.77 | 58.39 |
| 16-20 | 137 | 30,691.02 | 206,006.71 | 66.56 | 68.61 |
| 21 or more | 487 | 38,494.19 | 352,729.83 | 96.93 | 110.88 |
| Urban Counties | | | | | |
| 0 | 5 | 54,620.00 | 119,096.20 | 69.34 | 62.65 |
| 1 | 12 | 46,928.67 | 198,600.00 | 71.74 | 69.09 |
| 2 | 11 | 48,199.64 | 145,360.27 | 63.61 | 52.91 |
| 3 | 7 | 51,990.00 | 209,040.00 | 82.69 | 79.32 |
| 4 | 7 | 35,077.14 | 170,645.00 | 51.01 | 53.15 |
| 5 | 5 | 61,815.20 | 259,059.20 | 95.51 | 84.43 |
| 6 | 8 | 74,705.00 | 223,630.63 | 88.06 | 73.46 |
| 7 | 5 | 46,620.60 | 299,782.00 | 92.91 | 96.69 |
| 8 | 8 | 103,904.38 | 407,623.25 | 125.42 | 164.17 |
| 9 | 3 | 64,328.00 | 350,931.33 | 101.29 | 120.34 |
| 10 | 8 | 39,422.50 | 396,250.13 | 104.88 | 142.97 |
| 11-15 | 23 | 57,572.04 | 337,822.87 | 111.18 | 132.48 |
| 16-20 | 16 | 71,882.44 | 349,525.13 | 128.10 | 118.79 |
| 21 or more | 721 | 282,471.46 | 1,427,966.50 | 834.97 | 503.85 |

Note: 1) Population density is measured as population per square mile.

Table 4a
Number of ISPs in the Market by Type of ISP

| Market Definition: County of Residence Only | | | | | | | |
|---|--------------------|-------------------------------|------------------------------------|----------------------------------|---------------------------------------|----------------------------------|---------------------------------------|
| Number of ISPs in Market | Number of Counties | Number of Counties Local Only | Population Local Only ¹ | Number of Counties Regional Only | Population Regional Only ¹ | Number of Counties National Only | Population National Only ¹ |
| 0 | 1,108 | | | | | | |
| 1 | 719 | 280 | 8,219,116 | 425 | 8,390,558 | 14 | 1,525,281 |
| 2 | 328 | 78 | 3,628,301 | 99 | 2,388,694 | 6 | 210,339 |
| 3 | 168 | 30 | 2,440,282 | 30 | 733,274 | 0 | 0 |
| 4 | 94 | 9 | 1,336,104 | 20 | 690,366 | 4 | 99,565 |
| 5 | 63 | 4 | 747,570 | 4 | 94,178 | 1 | 44,280 |
| 6 | 44 | 0 | 0 | 5 | 230,225 | 0 | 0 |
| 7 | 22 | 1 | 324,043 | 1 | 26,202 | 1 | 18,212 |
| 8 | 33 | 1 | 492,528 | 0 | 0 | 0 | 0 |
| 9 | 22 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 27 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-15 | 86 | 0 | 0 | 2 | 64,790 | 0 | 0 |
| 16-20 | 42 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 or more | 354 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 3,110 | 403 | 17,187,944 | 586 | 12,618,287 | 26 | 1,897,677 |

Table 4b

| Market Definition: County of Residence and All Counties Within 30 Miles | | | | | | | |
|--|---------------------------|--------------------------------------|--|---|---|---|---|
| Number of ISPs in Market | Number of Counties | Number of Counties Local Only | Population Local Only¹ | Number of Counties Regional Only | Population Regional Only¹ | Number of Counties National Only | Population National Only¹ |
| 0 | 321 | | | | | | |
| 1 | 185 | 100 | 1,343,322 | 82 | 991,705 | 3 | 19,282 |
| 2 | 217 | 84 | 1,637,975 | 100 | 1,428,044 | 1 | 15,531 |
| 3 | 140 | 36 | 718,529 | 46 | 696,843 | 0 | 0 |
| 4 | 163 | 28 | 765,626 | 41 | 727,796 | 1 | 24,422 |
| 5 | 105 | 12 | 328,187 | 13 | 177,828 | 0 | 0 |
| 6 | 105 | 9 | 242,489 | 13 | 188,641 | 0 | 0 |
| 7 | 64 | 4 | 151,350 | 5 | 49,547 | 0 | 0 |
| 8 | 81 | 4 | 488,282 | 10 | 163,725 | 1 | 30,663 |
| 9 | 67 | 1 | 34,152 | 6 | 115,577 | 0 | 0 |
| 10 | 78 | 1 | 35,620 | 10 | 198,571 | 0 | 0 |
| 11-15 | 223 | 0 | 0 | 14 | 312,468 | 1 | 18,212 |
| 16-20 | 153 | 0 | 0 | 4 | 138,230 | 0 | 0 |
| 21 or more | 1,208 | 0 | 0 | 2 | 64,790 | 0 | 0 |
| Total | 3,110 | 279 | 5,745,532 | 346 | 5,253,765 | 7 | 108,110 |

Note: 1) For the calculations in these columns, the county of residence is treated as the unit of observation.

Table 1, Appendix

| Market Definition: County of Residence and All Contiguous Counties | | | | |
|---|---------------------------------------|---|---|--|
| Number of Providers in Market | Number of Counties[†] | Percentage of Population in These Counties | Cumulative Population Percentage | Percent of These Counties Urban |
| 0 | 52 | 0.14 | 100.00 | 1.92 |
| 1 | 111 | 0.40 | 99.86 | 4.50 |
| 2 | 124 | 0.57 | 99.46 | 4.03 |
| 3 | 132 | 0.68 | 98.89 | 0.76 |
| 4 | 104 | 0.59 | 98.21 | 3.85 |
| 5 | 88 | 0.44 | 97.61 | 3.41 |
| 6 | 92 | 0.54 | 97.17 | 4.35 |
| 7 | 86 | 0.71 | 96.63 | 4.65 |
| 8 | 72 | 0.53 | 95.92 | 2.78 |
| 9 | 74 | 0.65 | 95.38 | 4.05 |
| 10 | 77 | 0.59 | 94.74 | 3.90 |
| 11-15 | 244 | 2.21 | 94.15 | 7.38 |
| 16-20 | 187 | 2.14 | 91.93 | 9.09 |
| 21 or more | 1,667 | 89.79 | 89.79 | 46.13 |

Note: 1) For the calculations in the final three columns, the county of residence is treated as the unit of observation.

Table 2, Appendix

| Market Definition: County of Residence and All Contiguous Counties | | | | | |
|---|---------------------------|-------------------------------|---------------------------------|---|---|
| Number of Providers in Market | Number of Counties | Mean Population-County | Mean Population - Market | Mean Pop. Density¹ - County | Mean Pop. Density¹ - Market |
| 0 | 61 | 7,441.93 | 61,582.26 | 108.85 | 20.28 |
| 1 | 120 | 9,834.16 | 82,496.96 | 89.87 | 28.61 |
| 2 | 137 | 12,791.47 | 95,640.39 | 62.97 | 27.93 |
| 3 | 127 | 13,552 | 109,040.67 | 27.23 | 30.24 |
| 4 | 102 | 16,308.53 | 123,782 | 54.73 | 36 |
| 5 | 91 | 13,887.42 | 134,595.55 | 45.18 | 38.49 |
| 6 | 100 | 18,958.67 | 156,593.35 | 55.42 | 51.66 |
| 7 | 89 | 20,371.73 | 158,305.18 | 55.61 | 49.44 |
| 8 | 86 | 22,461.26 | 182,315.87 | 54.52 | 69.81 |
| 9 | 70 | 32,775.84 | 177,916.07 | 85.82 | 53.22 |
| 10 | 70 | 22,904.13 | 191,623.73 | 43.4 | 52.52 |
| 11-15 | 262 | 24,658.67 | 205,854.97 | 60.08 | 54.08 |
| 16-20 | 185 | 28,891.25 | 240,844.18 | 69.83 | 57.95 |
| 21 or more | 1,615 | 145,695.53 | 935,305.83 | 390.76 | 271.21 |

Note: 1) Population density is measured as population per square mile.

Table 3, Appendix

| Market Definition: County of Residence and All Contiguous Counties | | | | | |
|--|--------------------|--------------------|--------------------|------------------------------------|------------------------------------|
| Number of Providers | Number of Counties | Mean Pop. - County | Mean Pop. - Market | Mean Density ¹ - County | Mean Density ¹ - Market |
| Rural Counties | | | | | |
| 0 | 51 | 6,971.18 | 62,864.27 | 87.04 | 19.80 |
| 1 | 106 | 8,289.63 | 67,825.68 | 61.76 | 17.34 |
| 2 | 119 | 11,809.79 | 83,968.29 | 66.34 | 23.54 |
| 3 | 131 | 13,598.52 | 110,009.02 | 24.56 | 27.58 |
| 4 | 100 | 13,935.65 | 115,342.08 | 50.39 | 30.86 |
| 5 | 85 | 12,959.05 | 120,777.34 | 25.72 | 31.93 |
| 6 | 88 | 14,743.38 | 128,618.40 | 26.94 | 33.24 |
| 7 | 82 | 19,833.80 | 145,551.44 | 37.99 | 42.64 |
| 8 | 70 | 19,742.39 | 155,487.56 | 40.60 | 44.59 |
| 9 | 71 | 21,538.13 | 166,262.99 | 60.30 | 45.90 |
| 10 | 74 | 20,194.23 | 171,302.20 | 61.87 | 49.84 |
| 11-15 | 226 | 21,346.44 | 192,097.50 | 37.82 | 45.86 |
| 16-20 | 170 | 26,755.87 | 215,505.76 | 41.45 | 48.10 |
| 21 or more | 898 | 32,609.48 | 484,407.74 | 51.37 | 90.96 |
| Urban Counties | | | | | |
| 0 | 1 | 6,530.00 | 59,298.00 | 1,088.33 | 78.02 |
| 1 | 5 | 34,197.40 | 277,552.60 | 994.09 | 266.89 |
| 2 | 5 | 21,516.00 | 188,330.00 | 86.66 | 122.27 |
| 3 | 1 | 20,959.00 | 241,630.00 | 85.20 | 110.99 |
| 4 | 4 | 43,095.25 | 347,431.75 | 157.15 | 149.27 |
| 5 | 3 | 19,851.00 | 144,041.67 | 618.08 | 213.09 |
| 6 | 4 | 30,951.00 | 402,063.75 | 633.21 | 259.83 |
| 7 | 4 | 63,404.50 | 474,275.50 | 156.14 | 206.97 |
| 8 | 2 | 12,839.50 | 333,311.00 | 421.97 | 728.34 |
| 9 | 3 | 59,335.67 | 270,913.00 | 82.10 | 51.84 |
| 10 | 3 | 20,800.67 | 330,680.00 | 48.18 | 92.11 |
| 11-15 | 18 | 56,121.44 | 357,420.89 | 363.11 | 185.02 |
| 16-20 | 17 | 64,680.29 | 357,060.88 | 106.33 | 104.80 |
| 21 or more | 769 | 269,571.23 | 1,416,272.42 | 769.13 | 467.91 |

Note: 1) Population density is measured as population per square mile.

Table 4, Appendix

| Market Definition: County of Residence and All Contiguous Counties | | | | | | | |
|---|---------------------------|--------------------------------------|--|---|---|---|---|
| Number of ISPs in Market | Number of Counties | Number of Counties Local Only | Population Local Only¹ | Number of Counties Regional Only | Population Regional Only¹ | Number of Counties National Only | Population National Only¹ |
| 0 | 52 | | | | | | |
| 1 | 111 | 66 | 675,430 | 41 | 352,525 | 4 | 21,733 |
| 2 | 124 | 59 | 737,314 | 25 | 214,074 | 5 | 64,497 |
| 3 | 132 | 22 | 318,923 | 25 | 292,152 | 0 | 0 |
| 4 | 104 | 15 | 197,021 | 14 | 203,326 | 0 | 0 |
| 5 | 88 | 7 | 100,668 | 15 | 118,362 | 1 | 5,615 |
| 6 | 92 | 1 | 10,731 | 12 | 63,595 | 0 | 0 |
| 7 | 86 | 2 | 13,855 | 5 | 80,714 | 0 | 0 |
| 8 | 72 | 2 | 58,026 | 6 | 45,742 | 0 | 0 |
| 9 | 74 | 0 | 0 | 5 | 80,919 | 0 | 0 |
| 10 | 77 | 0 | 0 | 6 | 102,363 | 0 | 0 |
| 11-15 | 244 | 0 | 0 | 8 | 129,717 | 0 | 0 |
| 16-20 | 187 | 0 | 0 | 5 | 126,088 | 0 | 0 |
| 21 or more | 1,667 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 3,110 | 174 | 2,111,968 | 167 | 1,809,577 | 10 | 91,845 |

Note: 1) For the calculations in these columns, the county of residence is treated as the unit of observation.

Figure 1

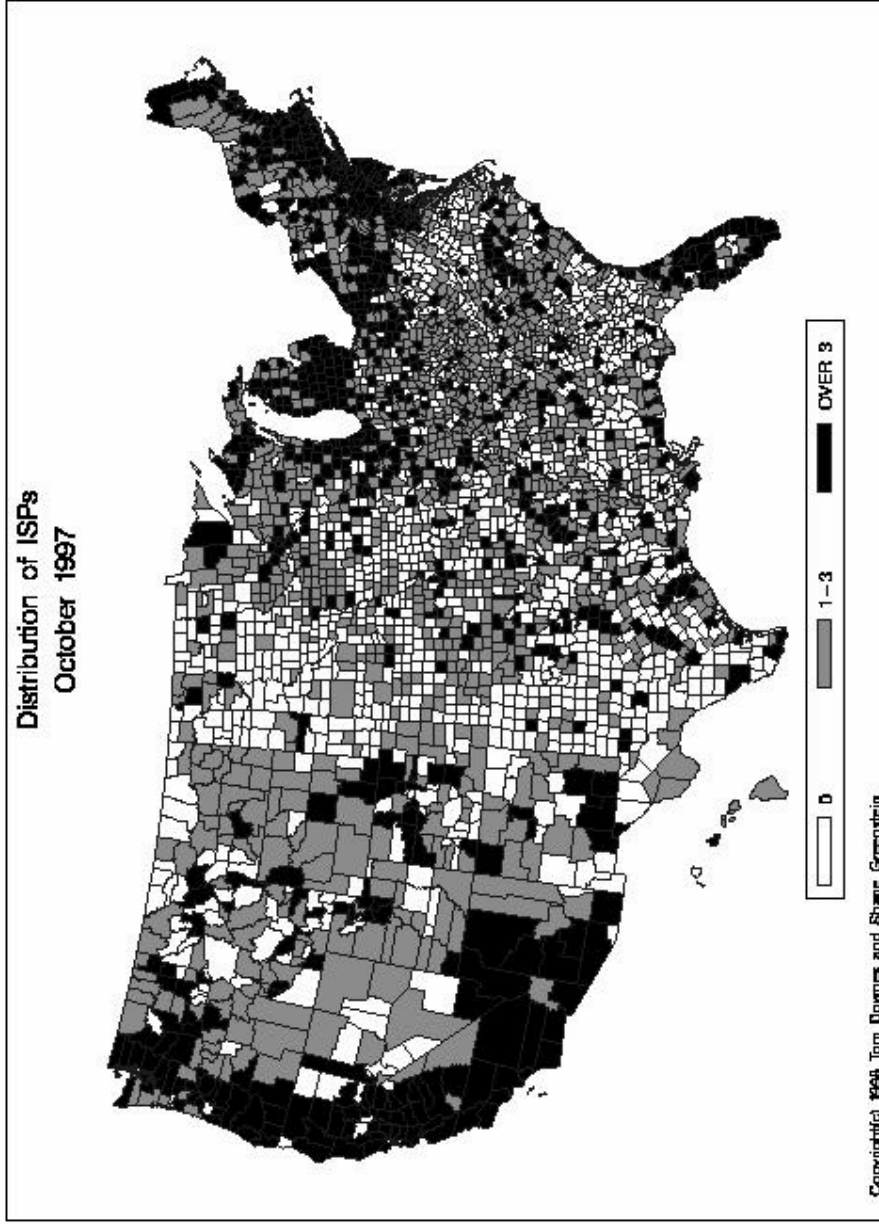


Figure 2

