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Do Commercial ISPs Provide Universal Access?

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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. We characterize the location of 54,000 points of presence (POPs), local phone numbers offered by commercial ISPs, in the spring of 1998. Markets differ widely in their structure, from competitive to unserved. More than 92% of the U.S. population has easy access to a competitive commercial Internet access market, while less than 5% of the U.S. population has costly access.

MOTIVATION

Governments frequently revisit the principle of universal service, making it an enduring issue in communications policy. In past eras this goal motivated policies that extended the national telephone network into rural and low-income areas. In the last few decades the same concerns motivated policies that eliminated large disparities in the rate of adoption of digital communication technology within the public-switched telephone network. More recently, many analysts have begun to anticipate a need to redefine universal service to account for Internet-related services and other combinations of communication and computing.[1]

The U.S. population is far from universal adoption of Internet services at home. No survey shows more than 25% adoption of Internet access in U.S. households, and no survey shows personal computer adoption exceeding 45% of households.[2] Yet, these surveys all beg the question about the availability of access—in other words, whether all households have access to Internet service at the same low cost. Because all consumers have access to the Internet at some price, the key question for most consumers is whether they can "cheaply" access the Internet. For many users *cheap* is synonymous with a local telephone call to a firm that provides Internet access for a fee. This open question motivates this study, which documents and analyzes the geographic spread of commercial Internet access.

This study focuses on understanding the geographic spread of commercial ISPs, the leading suppliers of Internet access in the United States. In the absence of changes in government policy, market-based transactions with ISPs will be the dominant form for delivery of online access for medium and small users.

Although our focus is the geographic spread of ISPs, our study will influence many facets of the literature on information infrastructure policy and cybergeography.[3] Because ISPs use the public-switch network, policy for this network should be sensitive to the commercial forces in the ISP market. There is no reason to anticipate that commercial ISPs provide universal access. Indeed, since there is little research into the organization of this industry, there is almost no framework to use for speculating.

In the first part of this chapter, we provide a brief introduction to the geographic diffusion of commercially oriented Internet access providers.[4] In the second part of the chapter we address a related empirical issue: Do all regions of the country receive similar access to Internet services provided by commercial firms? To answer this question, we characterize the location of more than 54,000 dial-up access points offered by commercial ISPs in Spring 1998.

Spring 1998 was a good time for such a survey. The industry's structure, although not completely stable, was not changing drastically every month. Most

1. For example, "The traditional concept of universal service must be redefined to encompass a concept more in line with the information superhighway of the future" (Anstey, 1993). That policymakers are sensitive to such statements is apparent in the 1996 Telecommunications Act, which contains provisions to collect funds to finance the diffusion of Internet access to public institutions, such as schools and libraries.

2. See, for example, Kridel, Rappaport, and Taylor (1997), Maloff Group International (1997), Compaine and Weinraub (1997), or Clemente (1998).

3. A complete bibliography is impossible. For some recent studies, see the references in Downes and Greenstein (1998).

4. The conclusions from the first half of the chapter will be familiar to regular readers of commercial press for the ISP industry. For surveys of the online industry and attempts to analyze its commercial potential, see Meeker and Dupuy (1996), Hoovers Business Press (1997), Juliussen and Juliussen (1996), or Maloff Group International (1997).

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 U.S. 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, and we should not expect this heterogeneity to disappear.
- More than 92% of the U.S. population had access to a competitive local ISP market. Less than 5% of the U.S. population lived in areas with no access to any provider and approximately 3% lived on the margin between easy access and no access.

THE STRATEGY AND ORGANIZATION OF THE ISP BUSINESS

This study examines the Internet access business just over 3 years after the National Science Foundation 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 many different regions of the United States.

Scope of Investigation

We analyze the ISP industry after the development of browsers and therefore focus attention on firms that provide dial-up service that enables a user to employ a browser. Furthermore, we make no distinction between firms that began as online 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

There is a growing market for direct access through the use of competitive access providers, but this service is primarily focused on business use within big cities. Many of the ISPs we analyze also provide direct access to business in the areas they serve (e.g., by building, renting, and maintaining T1 lines); but this activity will be in the background, as this study focuses on the dial-up market. There is also a market for 800 dial-up access, which, because of its expense for heavy usage, is targeted at business users who have occasional high-value online needs away from home (Barrett, 1997; Boardwatch Magazine, 1998; Maloff, 1997).

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 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.

The Maturing of the ISP Industry

As recently as 1995, only a few enterprises offered national dial-up networks with Internet access (Boardwatch Magazine, 1998), mostly targeting the major urban areas. At this time it was possible to run a small ISP on a shoestring in either an urban or rural area. In contrast, by Spring 1998, there were dozens of well-known national networks and scores of lesser known national providers. There were also many local providers of Internet access that served as the links between end-users and the Internet backbone. Shoestring operations seemed less common.

As a technical matter there is no mystery to starting and operating a dial-up ISP. A bare-bones independent ISP requires a modem farm, one or more servers to handle registering and other traffic functions, and a connection to the Internet backbone.[5] As an economic matter, starting and operating a node for a dial-up ISP involves many strategic considerations (Maloff, 1997; Stapleton, 1997). Higher quality components cost money and may not be necessary for some customers. High-speed connections to the backbone are expensive, as are fast modems. Facilities need to be monitored, either remotely or in person. Additional services, such as Web hosting and network maintenance for businesses, are also quite costly, as they must be properly assembled, maintained, and marketed. Providing added value may, however, be essential for retaining or attracting a customer base.

In sum, the geographic reach and coverage of an ISP is one of several important dimensions of firm strategy. Geographic coverage is determined in conjunction with choices of value-added services, scale, performance, and price. Providers that seek to provide national service must choose the regions in which they maintain POPs. The commercial motives of providers would lead us to expect to find that

5. For example, see the description in Kalakota and Whinston (1996), Leida (1997), the accumulated discussion on www.amazing.com/internet/faq.txt, or Kolstad's (1998) remarks at www.bsdi.com.

national firms cover areas of the United States that contain most of the population. In addition, local ISPs would be expected to target many of the niche markets that the national ISPs fail to address, especially those niches where users require a "local" component or customized service.

EMPIRICAL RESEARCH QUESTIONS

On the basis of the foregoing reasoning, we predict 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. Narrowing this set of possibilities is the focus of the following empirical work.

- *Question 1—The extent of geographic coverage*: Some parts of the country will not have access to low-cost commercial Internet providers. How does access change when density increases? What conditions characterize the competitive areas?
- *Question 2—The degree of competition in urban and rural areas:* We expeet most residents of urban and high-density areas will face a competitive and abundant supply of Internet access from commercial firms. What fraction of the population living in such areas has access to competitive ISP markets?

DATA

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 United States. We explain these data and methods in the following.

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. Although there is no single "yellow pages" for ISPs, there are a few enterprises that track ISPs in the United States. In Spring 1998, we surveyed every compilation of ISPs on the Internet. This study's data combine a count of the ISP dial-in list from Spring 1998 in *thedirectory* and a count of the backbone dial-in list for Spring 1998 in *Boardwatch* magazine.[6]

This choice was made for several reasons. First, *thedirectory* requests that its ISPs list the location of their dial-in phone numbers. Although not all of the ISPs

6. Current versions of these lists may be examined at www.thedirectory.org and www.boardwatch.com. This includes POPs found in the ISP section of *thedirectory.* This also includes POPs for ISPs listed in the *Boardwatch* backbone section.

comply with this request, most do, making it much easier to determine an ISP's location in a general sense. Second, *thedirectory* and *Boardwatch* both claim to maintain comprehensive lists, and these claims seem to be consistent with observation. That said, *thedirectory* consistently lists more ISPs than *Boardwatch*. On close inspection, it appears that this results from *thedirectory*'s more extensive coverage of small ISPs. Third, whereas *thedirectory* shows the location of most ISPs, *Boardwatch* only does so for backbone providers. In sum, *thedirectory* ISP list contains a more 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.

We used the following strategy to determine the location of each POP: When the city of a dial-in phone number was listed, we assumed the POP was in that city. 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 only provided information about their office, then we went to the Web page for the company. If there was no information about the company's network, the voice dial-in number for the ISP headquarters was used as an indicator of location.[7] When a city overlapped two counties and the phone number could not be used to place the POP in a county, the POP location was assumed to be the county in which the city had the greatest share of its land.

On final count, *thedirectory* contained 49,472 POPs not found in *Boardwatch*, *Boardwatch* contained 3,627 POPs in its backbone list not found in *thedirectory*, and 1,360 phone numbers came from both. The merged set contained 54,459 POPs that served as dial-in POPs. These phone numbers corresponded to a total of 41,117 unique firm-county presences, because many firms maintained multiple POPs in the same county, for 6,006 ISPs. Of these firm-county presences, more than three fourths were associated with just over 200 firms. Of the total number of ISPs, approximately half were ISPs for which we had only a single phone number.

Any conclusions reached here are potentially invalid if the data construction procedure generated sampling error that correlates with geography. We think not, although the preceding procedures may have imparted some small biases to some counties, which we describe later. 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 be-

7. This 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 45,983 phone numbers prior to adding firms that only provided a Web address. The additional 1,348 ISPs were responsible for 8,476 firm-county presences, which did not disproportionately show up in uncovered areas. They did, however, help identify entry of ISPs in a few small rural areas.

cause 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 following qualitative conclusions would change much if the omitted POPs were added.[8]

The preceding procedures may show less ISP entry than has actually occurred in counties that border on dense, urban counties. There is a tendency for new suburbs to use the telephone exchange of existing cities, which may be just over the county border. 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.

A 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 the coverage of the ISP may be more extensive than this declaration would indicate. We control for these potential biases through tables that treat as the market a county and its nearby neighbors.

In the best case scenario, the compilation in this study will give an accurate account of all commercial ISP coverage in the United States, particularly the coverage of those companies that advertise through standard channels. In the worst case scenario, counting the locations of the POPs listed in both directories will give an indication of how the ISP market looks to a consumer who does a small amount of searching. The compilation in this study probably lies between the worst and best cases, both of which are acceptable for a study of the spread of ISPs across the nation.

Definitions

What types of ISPs are on these lists and does their selection have any implications for the scope and coverage of this study? Both *thedirectory* and *Boardwatch* try to distinguish between bulletin boards and ISPs, where the former may consist of a server and modems, whereas the latter provide Web access, file transfer protocol, e-mail, and often much more.[9] Thus, the scope of this study is appropriately limited to firms providing commercial Internet access. We also excluded firms that only provided direct access.

8. Indeed, we tested this proposition on the data in the study. Even if a dozen national providers were left out of the sample, the basic qualitative conclusions would not change. For further evidence on the difference between the geographic coverage of local, regional, and national firms, see Downes and Greenstein (1998).

9. Extensive double-checking verified that *thedirectory* and *Boardwatch* were careful about the distinction between an ISP and a bulletin board.

Second, both lists concentrate on the for-profit commercial sector. For example, both eschew listing university enterprises that effectively act as ISPs for students and faculty. This is less worrisome than it seems, as commercial ISPs also gravitate toward the same locations as universities. This study's procedure, therefore, picks 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.

Thedirectory does list some free-nets. Their inclusion appears to depend on whether the free-net notifies *thedirectory* of their existence. A similar remark can be made for local cooperatives and quasi-public networks that are part of a state's educational or library system. In general, this study's procedures will identify the commercialized sector of Internet access but may underrepresent some nonprofit access alternatives, especially those that do not advertise in the standard online forums.

The tables provided later give a broad description of county features. Population numbers come from 1997 U.S. Bureau of the Census estimates. We label a county as urban when the Census Bureau gives it a metropolitan statistical area (MSA) designation, which is the broadest indicator of an urban settlement and includes about a quarter of the counties. For all tables, the data pertain to all states in the continental United States. These data also include the District of Columbia, which is treated as another county. County definitions correspond to standard Census Bureau county definitions, resulting in a total of 3,110 counties.

It is well known that slicing U.S. geography in this way has certain drawbacks—principally, county boundaries are political boundaries and do not directly correspond with meaningful economic market boundaries. We think that these drawbacks are overwhelmed by the benefits of using Census Bureau information. Moreover, it is also possible to control for the worst features of this drawback by calculating statistics that account for nearby counties.[10] Each of the 3,110 counties is the elemental observation, but 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 Census Bureau, 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.[11]

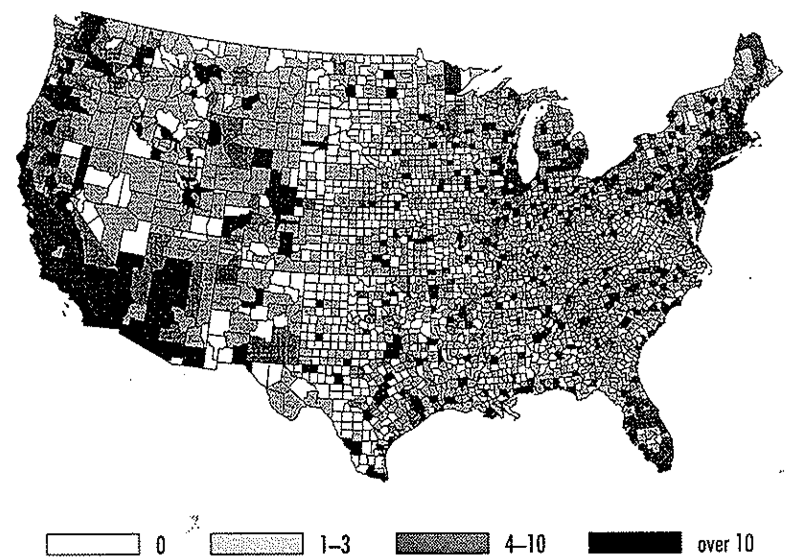
10. To see it both ways, see Downes and Greenstein (1998). We make this calculation using the U.S. Bureau of the Cens2us's (1992) *Contiguous County File, 1991: United States.*

11. We 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 all neighboring counties without distinguishing by their distance and also found that this was far too inconclusive, especially in the western United States. These latter results are included in the appendix of Downes and Greenstein (1998).

Maps

Figure 12.1 illustrates the density of location of ISPs across the United States at the county level. Black and gray areas indicate the extent of entry. 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.

FIGURE 12.1
Distribution of ISPs: May 1998.



THE GEOGRAPHIC SCOPE OF ISPS IN SPRING 1998

The summary of the nature of ISP coverage can be found in Tables 12.1, 12.2, and 12.3.

Urban–Rural Differences

Table 12.1 is organized by counties in the continental United States, where the central county is the unit of observation. Of the 3,110 counties, 247 have no POP supported by an ISP within their boundaries or the boundaries of a nearby county, 141 have only one, 191 have only two, and 115 have only three. Just under 4.5% of the U.S. population lives in counties with four or fewer ISPs nearby. As further evidence that low (high) entry is predominantly a rural (urban) phenomenon, more than 95% of the counties with 10 or fewer suppliers are rural.

TABLE 12.1
Entry of ISPs: Number of Providers in the "Market"
Market Definition: County of Residence and All Counties Within 30 Miles

Number of providers in market	*Number of counties*	*% of population in these counties*	*Cumulative population %*	*% of these counties urban*
0	247	0.84	100.00	1.21
1	141	0.59	99.16	4.96
2	193	1.12	98.57	4.15
3	115	0.69	97.45	6.09
4	172	1.23	96.76	5.23
5	98	0.81	95.53	6.12
6	117	1.10	94.71	5.13
7	81	0.71	93.62	3.70
8	83	1.00	92.91	13.25
9	73	0.77	91.91	4.11
10	72	0.71	91.14	2.78
11–15	278	3.06	90.42	7.91
16–20	147	1.88	87.37	14.97
21 or more	1,293	85.48	85.48	56.46

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

Table 12.1 offers the starkest finding of this study. More than 92% 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 Spring 1998, was predominantly rural and, then, only pertinent to a fraction of the rural population.

Table 12.2 elaborates on Table 12.1, giving the relationship between the presence of ISPs and some basic features of counties, principally population and population density. Although 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.

Table 12.3 permits exploration of the difference between urban and rural areas, shedding light on the relationship of density to entry. Counties are divided into those in urban and rural areas, and for each division the same summary statistics

as in Table 12.2 are provided. Apparent is the difference between urban and rural areas in the relationship between the population and density of the region and ISP entry. In rural areas, both population levels and density predict the level of entry into small counties (those with fewer than five suppliers). In contrast, in urban areas population levels do not strongly coincide with ISP entry. Because there are, however, few urban area observations with 10 or fewer ISPs, these results reflect a few observations and do not indicate a broad trend.

TABLE 12.2
Population and Population Density by Number of Providers in the "Market"
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 population density: county*	*Mean population density: market*
0	247	8,971.00	27,441.41	8.75	9.25
1	141	10,964.23	54,761.48	15.84	18.04
2	193	15,352.19	57,342.54	16.18	17.26
3	115	15,788.00	79,514.72	23.34	25.24
4	172	18,879.13	78,464.70	30.84	25.86
5	98	21,886.73	121,563.11	35.11	39.03
6	117	24,705.74	104,953.21	31.83	33.50
7	81	23,107.25	144,111.94	84.29	46.90
8	83	31,646.20	141,177.76	40.89	44.36
9	73	27,853.75	175,581.14	60.81	56.47
10	72	26,143.24	131,086.67	40.52	41.37
11–15	278	28,975.35	186,185.63	55.59	61.97
16–20	147	33,781.75	224,800.27	75.80	73.40
21 or more	1,293	174,195.64	943,724.38	506.30	327.82

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

Finally, the results in Table 12.3 are consistent with the view that there are economies of scale at the POP and that 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 12.3 does not provide conclusive evidence of these scale economies, however, because in constructing this table we did not control for potential determinants 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, however, insufficient evidence in these tables to test these competing hypotheses.

TABLE 12.3
Population and Population Density by Number of Providers in the "Market" and by Urban–Rural Status
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 population density: county*	*Mean population density: market*
Rural counties					
0	244	8,433.93	26,437.52	7.86	8.42
1	134	8,737.10	48,970.83	13.24	16.14
2	185	13,589.57	52,514.58	14.27	15.52
3	108	13,622.34	73,110.43	20.45	22.90
4	163	18,228.04	75,663.53	29.48	24.47
5	92	19,560.42	113,722.88	32.75	36.62
6	111	22,875.61	100,510.03	28.90	31.84
7	78	22,789.35	137,283.77	83.95	44.53
8	72	23,164.31	125,816.53	32.28	38.37
9	70	26,247.36	160,698.86	58.11	49.38
10	70	25,083.89	129,346.40	39.56	40.71
11–15	256	25,579.48	172,627.71	49.84	56.59
16–20	125	29,560.07	201,130.22	71.05	63.01
21 or more	563	37,470.21	331,932.03	91.14	105.12
Urban counties					
0	3	52,652.67	109,091.33	80.83	76.70
1	7	53,597.71	165,611.00	65.66	54.38
2	8	56,112.75	168,989.13	60.31	57.45
3	7	49,201.00	178,323.86	68.00	61.44
4	9	30,671.00	129,196.89	55.44	51.17
5	6	57,556.83	241,780.00	71.26	76.05
6	6	58,563.00	187,152.00	85.91	64.16
7	3	31,372.67	321,644.33	93.14	108.65
8	11	87,164.09	241,724.0	97.27	83.54
9	3	65,336.33	522,834.33	123.69	221.93
10	2	63,220.50	191,996.00	73.96	64.49
11–15	22	68,490.86	343,950.50	122.45	124.54
16–20	22	57,768.55	359,289.18	102.76	132.41
21 or more	730	279,642.79	141,558.75	826.48	499.58

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

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. Because

national firms face constant costs to the addition of POPs, they will not expand their network POPs in increasingly remote areas, bringing in fewer additional customers with each additional expansion. Hence, no national firm finds it economic to be ubiquitous.

Implications for Geographic Scope of Commercialized Internet Access

Several 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. Nevertheless, 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, although local and national POPs may face different thresholds. Third, some regions face competitive access markets and some do not. Most residents of urban and high-density areas have a competitive and abundant supply of Internet access from commercial firms. The part of the U.S. population that does not have access to a competitive ISP market lives in rural and low-density areas. We develop a few additional implications in the following.

The Scale of ISPs and Scope of Geographic Coverage

Downes and Greenstein (1998) showed that local and national firms place POPs at different locations, with national firms avoiding small, less densely populated rural areas. This pattern is 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 POP's 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 they make up for these losses with other complementary services tailored to rural areas. The second view only makes sense if the value-added services offered by a local POP have a strong local component; otherwise, a national firm could imitate it and profitably expand into rural areas. A third view[12] 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 the desire to provide community and public service, and not the profit motive, is the key driver of entry in rural areas. 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.

12. See, in particular, Garcia (1996) and Garcia and Gorenflo (1997).

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. 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 are already doing or proposing, will produce differences between urban and rural communities. If the percentage of revenue associated with non-dial-up business differs between ISPs in urban and rural areas, 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 foregoing results make clear that few residents of the United States 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.[13] Are the social benefits of extending ISPs further subsidies, even if those subsidies are targeted, worth an increase in these social expenses?

Commercial Motives and Public Support for the Internet

In the years leading up to the commercialization of the Internet, government support took many forms. The federal government provided subsidies for access to In-

13. For example, contrast the very different proposals in Sidak and Spulber (1998) and in Garcia and Gorenflo (1997). The former call for an end to implicit subsidies, and the latter come close to calling for subsidies for rural ISP service.

ternet protocol networks at remotely situated universities, software and shareware development, the development of backbone infrastructure, and the operation of many governance mechanisms. The commercialization of the Internet and the explosive growth that followed raise new questions about the proper role, if any, for government support in the future. In the spirit of this inquiry, we note that it is tempting to interpret our findings as indicating that commercial firms went far toward meeting goals for universal access. This would seem to lead to the conclusion that commercial firms accomplished much of this without government support. We must properly qualify such a conclusion.

First, in the mid-1990s the commercial Internet access industry still 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 software or hardware technologies and subsidies for the training of advanced engineers. This indirect subsidy for the industry as a whole cannot be disentangled from the commercial behavior we observe.

Second, the geographic shape of the commercial Internet access market may still retain significant 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, are still major providers of backbone today and still use much of the same backbone for commercial traffic. Significant commercial developments engendering new traffic patterns will alter those configurations in due time, but initially these commercial uses were built on top of the old structures. Some part of this infrastructure is attributable to the old subsidies, its expenses are sunk and providing services, and it should be properly called a subsidy today.

Third, providers might have entered in anticipation of future federal support. Anticipated support may take many forms. Recent programs, such as the development of Internet II and the disbursement of universal service funds as mandated by the 1996 Telecommunications Act, have received much publicity. We have no way to tell how much of the observed commercial behavior today can be attributed to investments made in anticipation of these expected funds.

Finally, our study has documented the lowest cost and lowest quality sector of the Internet access industry. Much of this industry exists in conjunction with the provision of other commercial services and is influenced by government support. Existing and future government programs may, directly or indirectly, encourage demand for high-speed access, thus influencing the overall profitability of an ISP business in a particular area. As a by-product, these programs may also lead to the development of the dial-up industry in a local area.

CONCLUSIONS

The commercial Internet access industry has an important geographic component that 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 have an important geographic component. The links between geographic coverage and market structure arise because an ISP simultaneously chooses several important dimensions of firm strategy, including geographic coverage.

The location pattern we observed in Spring 1998, particularly the failure of ISP service to spread to all parts of the country, is consistent with the existence of small 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, although some residents of rural areas faced less ideal conditions.

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. To what extent is entry influenced by the presence of a wealthy or educated population, an advanced telecommunications infrastructure, or a major educational institution? Answering these questions is a necessary first step toward properly structuring universal access policies.

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Proxy Models and the Funding of Universal Service

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A few years ago U.S. state and federal regulatory commissions and local and interexchange carriers recognized the need to modify the method used to provide support to high-cost areas. Many parties agreed that there was a need to construct an economic cost model that would capture the essential factors that drive cost variations across geographical areas.

Two fundamental steps are involved in constructing an economic cost model. The model algorithms, or platform, are formulas that represent the network and network engineering. The inputs to the model help define the cost of different facilities and expenses.

Often the selection of model inputs has been based on the opinion of subject-matter experts. The opinion of subject-matter experts is difficult to validate and therefore many regulatory commissions have voiced a preference for relying on data that are in the public domain. In this chapter we use data that are in the public domain to estimate the cost of the installing cables and poles, two of the most important inputs to an economic cost model. Through econometric analysis of the data, we are able to identify how the cost of installing plant varies as a function of density and rock, water, and soil conditions. Our results have been used by state regulatory commissions to evaluate the economic cost of service, and the Federal Communications Commission (FCC) is currently pursuing a similar analysis.