Building and Delivering the Virtual World: Commercializing Services for Internet Access

By Shane Greenstein*

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This study analyzes the service offerings of Internet Service Providers (ISPs), the commercial suppliers of Internet access in the United States. It presents data on the services of 2089 ISPs in the summer of 1998. By this time, the Internet access industry had undergone its first wave of entry and many ISPs had begun to offer services other than basic access. This paper develops an Internet access industry product code which classifies these services. Significant heterogeneity across ISPs is found in the propensity to offer these services, a pattern with an unconditional urban/rural difference. Most of the explained variance in behavior arises from firm-specific factors, with only weak evidence of location-specific factors for some services. These findings provide a window to the variety of approaches taken to build viable businesses organizations, a vital structural feature of this young market.

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1. Introduction

How do vendors construct viable and on-going economic entities in an evolving and technically-intensive marketplace? This study sheds light on these processes through analyzing the services at 2089 Internet Service Providers (ISPs) in the summer of 1998. This study investigates the propensity of an ISP to offer services other than routine and basic access.

In 1998 the industrial structure of the ISP market was changing. Three features characterize the change. For one, this market was *growing rapidly*, attracting thousands of entrants and many users, quickly achieving mass-market status (Clemente [1998]). Second, firms were becoming *nearly geographically pervasive*, even in many low density areas (Downes and Greenstein [1999]). And third, firms *were not settling* on a standard menu of services to offer. This paper is the first to take steps towards explaining this last pattern.

New services are an excellent example of how Internet technology had to be packaged in order to provide value to commercial users. In practice establishing new services involved more than simply buying and adapting capital goods. More typically it involved evaluating a technological possibility, making an educated guess about how to adapt it to customers, and tailoring investments to the goals of the ISP. Many factors potentially influenced this activity; this study statistically measures these factors, seeking to identify circumstances that produce variance in behavior across ISPs.

I investigate four types of services: frontier access, networking, hosting and web design services. Because no government agency, such as the Census or the Bureau of Labor Statistics, has yet to completely categorize these services, this study and its companion paper (Greenstein [2000b]) are the first economic analyses to develop and employ a novel Internet access product code. This categorization establishes a common language for understanding experiments with new services, translating many technically obscure commercial services into concrete terms accessible to a general reader.

The paper next estimates several statistical models of the determinants of an ISP's decision to offer non-basic services, dividing determinants into two classes, location-specific factors or firm-specific factors. Stated simply, do ISPs offer different services because the determinants of these choices vary between services or between locations? For example, the geographic dispersion of determinants, such as local demand or infrastructure, might explain the geographic dispersion of propensities to offer services. Alternatively, the dispersion of firm-specific factors which are associated with new services, such as firm

size, might be found disproportionately in urban areas.

The econometric analysis finds that firm-specific determinants are pivotal to the offering of non-basic services. These include measures of a firm's geographic scope, investments and its focus on non-technical users. There is only weak evidence of location-specific determinants, such as urbanization and presence of professionals. New services tend to cluster together at firms and tend to be available more frequently in high density areas, an outcome partly influenced by economics of scope between old and new services. More generally, the firm-specific factors that are associated with new services, such as firm size and a focus on satisfying market demand by unsophisticated users, are disproportionately found in ISPs located in urban areas. Economies of scale also appear to be mild for services other than frontier access.

Finally, networking and web design share many common market features, while high speed access and hosting share other determinants.

Explaining the variety of approaches firms take to developing new services in technology-intensive markets has long been a topic of discussion in the economics of technology, industrial organization and economic growth. This study's framework resembles that found in Bresnahan, Stern and Trajtenberg, [1997], in which a PC manufacturer's attempt to differentiate from common competitors may result in temporary returns if competitors eventually learn to provide close substitutes. Similarly, here an ISP uses new services to differentiate from other competitors. The open measurement question here, as there, concerns the dimensions over which the firms differentiate as well as their determinants. One novelty of this paper is its proposal for resolving these issues.

Expanding into new services is related to what Bresnahan and Trajtenberg [1995] call co-invention, the complementary invention which makes advances in general purpose technology valuable in particular places at particular points in time (see also Helpman [1998]). As with Augereau and Greenstein [2000], this study implements a simple and practical empirical identification strategy for analyzing the determinants of co-invention. This strategy builds on Bresnahan and Greenstein [1997] and Brynolffson and Hitt [1997], which used variation in user characteristics to empirically examine how co-invention processes influenced information technology user behavior. Unlike those papers, this study focuses on variation in suppliers' behavior and relates it to attempts to build viable organizations for new markets. In this sense, this study is the first to classify or analyze the determinants of co-invention from third party suppliers in Internet technology markets.

Finally, this study also takes steps toward empirically measuring the determinants of what studies

of organizations label mediation services in fluid environments or changes to the boundary of the firm in uncertain environments (e.g., Demsetz [1988], Spulber [1998] and many others). Accordingly, this study also borrow themes from many classic studies of organization adaptation, diffusion and learning, such as those by Griliches [1957], Rosenberg [1977], Nelson and Winter [1982] and many others.

2. The Internet Access Business after Commercialization

Internet technology is not a single invention, diffusing across time and space without changing form. Instead, it is a suite of communication technologies, protocols and standards for networking between computers. This suite is not valuable by itself. It obtains economic value in combination with complementary invention, investment and equipment.[1]

The NSF officially commercialized the Internet backbone in 1992. By 1993 the Internet connected more than one million hosts, though lack of a user-friendly interface meant that its use was confined largely to sophisticated users in scientific, educational, and military institutions. The World Wide Web protocol, allowing easy exchange of data between computers using a graphical interface, began a few years earlier with the invention of the URL and html. Browser software became available in 1993 beginning with Mosaic, the ancestor and model for Netscape, Internet Explorer and other browsers.

Commercial Internet Service Providers have been around at least since 1994 (Boardwatch, 1994), employing technical refinements developed over many years at academic modem pools and commercial bulletin boards. In the early years it was possible to run a small ISP on a shoe-string in either an urban or a rural area. These firms were devoted primarily to dial-up. However, this changed as the industry grew at an explosive pace. Consequently, by the summer of 1998, the time of this study, there were dozens of well-known national networks and scores of less-known national providers covering a wide variety of dial-up and direct access. There were also thousands of regional and local providers of Internet access that served as the links between end-users and the Internet back-bone (See Downes and Greenstein [1999] for detail). Over 92% of the US population had low cost access to commercial ISPs.

This explosion of entrants and the resulting geographic pervasiveness came about because technology did not serve as a barrier to entry, nor were there prohibitive costs to hiring mainstream programming talent. Providing basic access required a modem farm, one or more servers to handle

[1] For more on the commercialization of the Internet, see Greenstein [2000a].

registration and other traffic functions, and a connection to the Internet backbone.[2] Some familiarity with the non-proprietary standards of the web was required, but not difficult to obtain. Because so many students had used the technology in school, and because the standards were non-proprietary, anyone with some experience could use them or at least learn them quickly. As a result, a simple dial-up service was inexpensive to operate and a web page was quite easy to develop. Hence, many entrepreneurs took to the technology. So too did many personnel from incumbent firms in related markets, such as bulletin boards operators and personnel in computing services.

3. Determinants of Business Models in Technology-Intensive Markets

Standard economic analysis offers a number of explanations for why different firms might offer different arrays of services. As emphasized in Bresnahan, Stern and Trajtenberg [1997], one way to frame such a question is to view it as an attempt to differentiate from common competitors in order to create rents. In that study PC firms try to push technical frontiers, develop local or national brand names or combine recent technical advances with less technical businesses in unique ways. Such differentiation may arise as a response to firm-specific assets or other competitive factors, and these returns may be temporary if competitors eventually learn to provide close substitutes.

A similar line of reasoning appears frequently in ISP trade publications, where analysts distinguish between two types of activities other than basic access, technically difficult access and complementary services. Accordingly, this is one approach to modeling differentiation.

! *Offering technically difficult access:* High-bandwidth applications present many technical issues which challenge the skills and capital constraints of many ISPs. The slow diffusion of commercially viable high-speed access markets is widely regarded as a major bottleneck to the development of the next generation of Internet technologies.

! *Offering services that are complementary to basic access:* Providing additional services became essential for retaining or attracting a customer base. Many ISPs instead tried to develop additional services, such as filtering, hosting, web-design services and network maintenance for businesses. Some of these were quite costly, as they had to be properly assembled, maintained, and marketed. Many of these

[2] For example, see the description in Kalakota and Whinston [1996], Lieda [1997], the accumulated discussion on www.amazing.com/Internet/faq.txt, http://www.isps.com/, or Kolstad [1998] at www.bsdi.com.

services push the boundaries of existing telecommunications and computing market definitions.

What service will an ISP offer? The discussions in Berry [1992], which examined airline entry into new routes, provides useful guidance for empirically modeling entry into markets in which a firm has not previously competed. Firms may choose to expand into one, some or all possible markets; Berry posits that the presence of a firm in a market indicates positive expected profitability to offering service. A similar insight applies to this setting. For many ISPs, much of the equipment and R&D associated with establishing basic access facilities was already sunk. *Expanding* the scope of those facilities beyond basic access into a new service involved further expenses. Considerable commercial uncertainty surrounds the ultimate value of such expansion. Achieving minimum efficient scale was an important concern for ISPs with small customer bases, so too was finding economies of scope with existing services. Despite this uncertainty, one can interpret presence as a signal of positive expected profitability to offering service.

Sutton's [1991] theory of endogenous sunk costs also highlights a related consideration. If large scale sunk investments lead to firm-specific demand expansion and if providers find economies of scope across these services, then the market can only support a small number of providers. The open question concerns the geographic scope of these Sutton economies. If these arise at a national level, then the number of national providers will be small. However, if thousands of geographically dispersed ISPs find economies of scope between Internet access and a line of service with location-specific elements, then providers at a local level could survive Sutton economies at the national level. That is, national service and local service may remain imperfect substitutes in the eyes of some users and the market could retain a mix of local and national firms. The open question is whether there is any evidence of economies of scope between locations-specific service and ISP line of business.

By the time of this study AOL, AT&T, Mindspring/Earthlink, and many other ISPs, focused on building large national firms, investing heavily in R&D and marketing expenditures. Other ISPs, such as those with a regional or city focus, deliberately focused on new services which enhance their marketing advantages at a local level. This study primarily examines the latter actors.

How does one empirical investigate which serrvices will a local firm pursue? The theory of general purpose technologies and co-invention (Bresnahan and Trajtenberg [1995], Helpman [1998]) provides a framework. Differentiation from a common competitor can be understood as an attempt to customize a malleable technology to different locations, firms, and time trends. That is, many firms and locations face the same secular technological trends. *Differences* across firms at any point in time (or over time) arise

when decision makers face different incentives arising from different demand conditions, different quality of local infrastructure, different richness of labor markets for talent, or different quality of firm assets. These create a variety of economic incentives for adapting Internet infrastructure to new uses and applications.

In summary, existing theory suggests that there should be considerable heterogeneity in the behavior of ISPs, partly as a reflection of real differences in economic conditions and partly a reflection of different evaluations of similar, yet uncertain, economic circumstances. Beyond such a general statement, theory does not provide specific guidance about which factors were likely to matter most to ISPs' decisions, nor does the trade press have anything other than platitudes to guide analysis of why difference arise. Which factor matters most is an empirical question.

In this study, empirical identification rests on comparing the decisions of similar ISPs who face different local conditions. It also rests on contrasting the behavior of ISPs who operate in some locations but with different firm-specific constraints. A similar approach was used by Augereau and Greenstein [2000], which examines ISP incentives to upgrade the quality of their equipment. This identification strategy has its origins in many studies of innovative behavior.

! **Firm specific factors:** A well-known line of research about firm behavior in evolving markets emphasizes the number of firm-specific factors shaping the incentives to bring new technology into use (See, e.g., Demsetz [1988] or Nelson and Winter [1977] for a summary). In this instance, ISPs came to the new opportunities with different skills, experiences and commercial focus. In the face of considerable firm-specific commercial uncertainty, ISPs purchased and installed their own capital equipment, publicized brand and service agreements, and made other long-lasting investments. Many of these investments could commit the ISP to a particular array of services, even before market demand was realized or new commercial opportunities were recognized. Many such investments also foster economies of scope across old and new services or between clusters of new services.

! **Location specific factors:** Another well-known line of economic research, dating at least to Griliches [1957], has emphasized the geographic dispersion of the determinants of incentives to adopt new technology. Geographic variation arises for many reasons. For example, while basic dial-up access is widely available in all urban areas and many rural areas, there is great variance in market structure on a local level. Some areas have low densities, precluding data services which require a minimum scale. Dense urban areas contain more suppliers from a wide variety of backgrounds, while less dense areas contain few suppliers, fostering differences in competitive pressures. In addition, many ISPs deliberately customize

frontier technology to the needs of enterprises doing business at a specific time in a specific place, trying to establish long-lasting relationships with a nearby customer base. The costs and benefits of this approach may vary by region. Infrastructure differs by regions, so too does demand, as sophisticated users are unevenly distributed across geographic regions.

4. Data

To characterize the offering of service in a quantitative way, some research assistants and I examined the business lines of 3816 Internet service providers in the United States who advertise on *thelist*.[3] This site, maintained by Meckler Media, provides the opportunity for both large and small ISPs to advertise their services. ISPs fill out a questionnaire where the answers are partially formatted, then the answers are displayed in a way that allows users to compare different ISP services. Greenstein [2000b] examines all 3816 ISPs. This study examines 2089 small and medium sized ISPs. For these ISPs it is possible to identify both firm and location specific determinants.[4]

A. Generating the Sample

By construction every firm in the sample provides some amount of dial-up or direct access and basic functionality, such as email accounts, shell accounts, IP addresses, new links, FTP and Telnet capabilities. It contains many observations from ISPs in rural areas and from virtually all the mainstream ISPs. These ISPs, however, under-represent ISPs in small towns (e.g., where advertising on the web is not necessary) and quasi-public ISPs (e.g., rural telephone companies). In addition, this sample does not examine firms who offer non-basic services but who do not offer basic access.[5]

The sample is comprised of small firms so I could identify local conditions for each firm. To construct the dataset I first restricted the sample to 3300 ISPs found in 20 or fewer area codes, where this latter variable comes from *thelist*. This isolates regionally dispersed decision makers. Second, the sample was compared against approximately 5400 ISPs in the Downes and Greenstein [1999] who were in five or

[3] For details see the Appendices, which are listed on the web page for the Journal of Industrial Economics.

[4] Results for all 3816 ISPs use fewer covariates (about location) and are not substantively different. However, these estimates do contain an additional insight about size. See Appendix I on the JIE web site.

[5] As noted in Downes and Greenstein [1999], there is also a subtle empirical bias in any study of ISPs. All inferences in this sample are conditional on observing the ISP in the access business. We do not observe those who considered this business, but did not choose it.

fewer counties. Why five or fewer counties? Counties are a less coarse way to identify local service territories and local market conditions than the next best alternative, using the area codes included in *thelist.*[6] In practice, the Downes and Greenstein [1999] dataset for small ISPs comes from 1998 spring/summer listings in *thedirectory*, another forum in which ISPs advertise. *Thedirectory* places emphasis on listing the local dial-up phone numbers for many ISPs,[7] which permits identification of the local points of presence (POPs) for ISPs, and, hence, the local geographic territories served by any ISP who offers dial-up service.[8]

The data set emphasizes accuracy over increases in sample size. An ISP was included in the sample if the ISP listed the same domain name for the home page in both *thedirectory* and *thelist.*[9] Since the dataset is large enough for the statistical purposes below and there was no hope of getting a census of all ISPs, the benefits of absolute accuracy overwhelmed the potential risks of being inaccurate for a few firms.[10]

These 2089 ISPs is not a complete census of small ISPs, but it is a random sample of small ISPs. Comparisons of the 2089 ISPs in the analysis sample with the roughly 5400 small ISPs in Downes and Greenstein [1999] showed little difference in the features of the service territories. For example, in the sample 83.5% of the ISPs are in urban counties, using the broadest definition of urban from the US Census. In Downes and Greenstein, only 81.1% are in urban counties. Other than this slight difference, there is no qualitative difference in the average features of the territories covered by small ISPs in the two

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[6] In some dense urban counties, the number of area codes exceeds the number of counties, but for most of the country the number of counties vastly exceeds the number of area codes. There are over 3000 counties in the US and less than 200 area codes.

[7] The other source of data for Downes and Greenstein [1999] is the *Boardwatch* backbone list, which concentrates mostly on national ISPs (Boardwatch [1998]).

[8] This is an artifact of the US local telephone system, which tends to charge telephone calls by distance. Hence, the location of a local phone number from an ISP is an excellent indicator of the local geographic territory covered by the ISP. See Downes and Greenstein [1999] for further detail.

[9] It was discovered that it is relatively common for several different firms to maintain similar company names and similar domain names, heightening potential confusion. In addition, many ISPs maintain several similar "home pages" with different domain addresses for a variety of reasons (e.g., tracking traffic from different sources, marketing under different organizational umbrellas, etc.).

[10] Because two sets of company names are maintained by two completely unrelated lists, *thedirectory* and *thelist*, each of whom uses different abbreviations and possibly different domain names, many ambiguities arose. It is certainly the case that many of the 1300 firms from *thelist* which are not included in the analysis sample are, in fact, in the Downes and Greenstein [1999] data. However, verifying these matches was tedious and potentially subjective, rendering it almost infeasible.

data sets. Moreover, the number of small ISPs found in each county in the Downes and Greenstein dataset and in the sample correlates at .94, as one would expect if the 2089 ISPs were nearly a random selection.[11] Differences between this sample and a sample of national firms are highlighted in Greenstein [2000b].

Figure 1 presents a map where a county is blackened if it contains at least one ISP from the analysis sample. There are 905 such counties represented in this sample, with representatives from virtually every urban area in the US as well as several hundred rural counties.

B. Classifying the Services of ISPs

The first goal is to classify the activities of Internet access firms. No product code exists for this industry, as it has grown faster than government statistical agencies can classify it. Any classification system for an evolving industry will necessarily reflect the judgement of contemporary trade literature. As in Bresnahan, Stern and Trajtenberg [1997], some points of differentiation, such as being on a frontier, are necessarily defined in a way that eventually becomes dated. This will also be true of some of the complementary services, particularly those related to electronic commerce, which are rapidly changing at the time. Based on contemporary magazines, I grouped services into five broad categories: basic access, frontier access, networking, hosting, and web page design. These broad categories provide a feasible and consistent view of economic activity of ISPs, emphasizing which activities push out frontier access and which provide services complementary to access. Since only coarse information was available about the characteristics of demand, these categories generally reflect contemporary supplier's view of how activities should be grouped together. See Appendix III for the complete description and Table 1 for a general outline.

- *Basic access* constitutes any service slower than and including a T-1 line, including fractional T-1. Many of the technologies inherited from the pre-commercial days were classified as complimentary to basic access, not as a new service.
- *Frontier access* includes any access faster than a T-1 line, which is becoming the norm for high-speed access to a business user. It also includes ISPs which offer direct access for resale to other ISPs or

[11] The correlation between the ISPs per county in the two datasets is .94 when Downes and Greenstein [1999] only examine ISPs in five counties or less. The correlation is, not surprisingly, lower when we correlate the number of ISPs in the analysis sample per county with the entire Downes and Greenstein dataset, which includes all national and regional firms. In this case, the correlation is .82. This is because larger firms tend to disproportionately locate in urban areas.

data-carriers, that is, it also includes ISP, who offer parts of their own "backbone" as a resale to others.[12]

! *Networking* involves activities associated with enabling Internet technology at a user's location. All ISPs do a minimal amount of this as part of their basic service in establishing connectivity. However, an extensive array of these services, such as regular maintenance, assessment of facilities, emergency repair, and so on, are often essential to retaining business customers. Note, as well, that some of these experimental services could have been in existence prior to the diffusion of Internet access; it is their offering by Internet access firms that makes them a source of differentiation from other ISPs.

! *Hosting* is typically geared toward a business customer, especially those establishing virtual retailing sites. This requires the ISP to store and maintain information for its access customers on the ISP's servers. Again, all ISPs do a minimal amount of hosting as part of basic service, even for residential customers (e.g., for email). However, some ISPs differentiate themselves by making a large business of providing an extensive array of hosting services, including information provision, site-analysis tools, and some services related to the conduct of electronic commerce.

! *Web Design* may be geared toward either the home or business user. Again, many ISPs offer some passive assistance or help pages on web page design and access. However, some offer additional extensive consulting services, design custom sites for their users, provide services associated with design tools and web development programs. Most charge fees for this additional service.

Other services were put into four other groups: traditional computing services (e.g., PC sales and service), traditional telecommunications (e.g., cellular phone sales and service), consulting, and miscellaneous services (e.g., copying, cafes and photography). While in practice these last four were less common, the non-access lines of business of ISPs are revealing. For the most part, if an ISP advertises this business service, this was this firm's primary business before the firm became an ISP.

Once again, accuracy took precedent over other considerations. I will only record a service line if the ISP clearly states it as such . In practice, descriptions of each ISP's services on *thelist* was classified into standard "phrases" which are then mapped to particular services at particular ISPs. In other words, an ISP offers networking services if that ISP uses one of the “phrases” which corresponds to networking

[12] Speed is the sole dimension for differentiating between frontier and basic access. This is a practical choice. There are a number of other access technologies just now becoming viable, such as wireless access, which are slow but technically difficult. Only a small number of firms in this data are offering these services and these are coincident with offering high speed access.

activity. Similar exercise followed for hosting, web design and frontier access. In general, these methods should *undercount* the offering of any particular service line since many phrases were uninformative.[13] In addition, the lines between different services are often, but not always, sharp. This warrants a cautious interpretative approach, because ambiguities in definitions naturally arise.

Table 1 lists the most common phrases for each line of business.[14] By definition, every ISP has at least one useful phrase indicating activity in the access business. An ISP could be no service other than basic access, one other service or more than one. On average, an ISP had 8.6 useful phrases (standard deviation of 4.6, maximum of 40). The main statistical findings from applying the classification scheme are listed in Table 1.

C. The Service Lines of ISPs

Tables 1 and 2 present statistics for experimentation by ISPs in the sample. Of the 2089 firms in the sample, 1260 (60%) have at least one line of business other than basic dial-up or direct Internet access. Table 1 shows that 514 provide high speed access, 440 networking, 460 web hosting, 757 web page design. For such a cautious method, this reveals quite a lot of non-access services by firms in the access business.[15]

Table 2 examines the two different types of services other than basic access. Specializing in very high-speed Internet services is one type of service that distinguishes a firm from its competitors. As has been noted in many places (e.g., Kolakota and Whinston [1996]), greater and greater speeds are harder to obtain (as a technical matter) and costly to reliably provide (as a commercial matter). In contrast, specializing in hosting, networking service or web design can also distinguish a firm from its competitors.

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[13] The approach depended on the ISP describing in concrete terms the businesses they offer. For example, no additional line of business was assigned to a ISP who advertised "Call for details" or "We are a friendly firm." The vast majority of unused phrases were idiosyncratic phrases which only appeared once with one firm, defying general characterization. There were 1105 such phrases (and 6,795 unique useful phrases), which occurred 1406 times (out of 35,436 total phrases). In other words, most of the unused phrases occurred only once and described attributes of the firms which had nothing to do with their lines of business (e.g., HQ phone number, contact information or marketing slogans). The most common unused phrase was “etc.”

[14] The entire list of phrases and the correspondence table are available from the author on request.

[15] One of the most difficult phrases to classify was general "consulting" -- i.e., consulting which did not refer to a specific activity. Of all these vague consulting cases, all but 12 arose in the 1836 firms who provide networking, hosting and web design. Hence, the vast majority of consulting activity is accounted for by the present classification methods as one of these three complementary activities.

Many of these services require trained personnel and may be difficult to do profitably. Hence, these two types of differentiation might be done by the same firms for commercial reasons, but there is no technical reason for it.

The fraction of firms in networking, hosting, and web design is higher among those with high speed access, but the relationship is not very strong. Of the 514 in high speed access, 314 (61%) provided networking, hosting or web design. By comparison, of the 1575 not providing high-speed access, 200 (12.6%) did so. Similarly, of the 1050 providing networking, hosting or web design services, 314 (30%) provided high speed access. Of the 1039 not providing networking, hosting and web design, 200 (19.2%) provided high speed access.

Further comparisons of different lines of business are in Greenstein [2000b]. These reinforce the point that different firms carry different non-basic services. For example, of those without frontier access, 26% have only one new service, 15% have two and 4% have all three. Of those with frontier access, the propensities are mildly different: 25% have only one new service, 24% have two, and 10% have all three. No obvious pattern governs their combination or clusters of services.

Table 1 shows the contrast between urban and rural areas. 1764 ISPs primarily serve urban areas.[16] Of the 1764 ISPs, 26.9% offer frontier access, 22.9% offer networking services, 23.5% offer hosting services, and 38.6% offer web design services. Of the 325 ISPs primarily found in rural areas, 12.0% offer frontier access, 11.0% offer networking services, 13.8% offer hosting, and 23.3% offer web design services. The propensities for rural ISPs are between 40% and 60% lower in each category category. A test for difference of means between urban and rural ISPs rejects the hypothesis that the propensity is the same between the urban and rural samples of ISPs. This holds for every type of activity.

These first results do not seem to be an artifact of survey bias. There is not enough evidence here to suggest something artificial about the relationship between the results and the effort it takes to fill out the survey from for *thelist.*[17]

[16] Each county an ISP serves is designated urban or rural by the US census. In the rare cases where an ISP serves a mix of urban and rural areas, if the majority of counties are urban, then an ISP is said to be urban.

[17] Geographic firm size (i.e., the total number of area codes in which the ISP offers service) is a good measure of a survey bias because the ISPs must expend effort to indicate the extent of their geographic coverage. If the number of phrases was low due to ISP impatience with the survey format, one would expect a strong relationship between firm size and the number of phrases. Since the correlation is positive but small, which is plausible for many reasons having nothing to do with survey bias, I conclude that the numbers of lines of business does not arise as an artifact of ISP impatience with the survey or other forms of laziness by the ISP.

5. The Determinants of Non-Basic Services

The above test is an unconditional comparison and says little about the determinants of outcomes. These findings do not control for urban/rural differences in population demographics, nor for urban/rural differences in firm-specific traits. In other words, the geographic dispersion of the endogenous variable might be explained by geographic factors, but it might also be explained by the geographic distribution of firm-specific factors. A careful inference requires an econometric model which measures the influence of firm-specific and location-specific determinants.

A. Model Selection

Table 3 includes summary statistics for all endogenous and exogenous variables, as defined below. In the discussion below, the matrix of these variables will be listed as "X", where X_i represents a vector of variables for observation i. Let i index ISPs where i = 1 through 2089. Let Y_{ni} = 1 if an ISP offers networking and zero otherwise. Let Y_{hi}, Y_{wi}, and Y_{fi} be defined similarly for hosting, web design and frontier access. These activities will be the sub-components for alternative specifications of the endogenous variable.

Several considerations determine the selection of an empirical model. First, the activity of interest – offering non-access service lines – is never directly observed. At best, it is observed with error, as represented by Y_{ni}, Y_{hi}, Y_{wi}, and Y_{fi}. Second, the best available measure of this activity is discrete.[18] Third, due to the data-collection method, the boundary definition for "activity" is subject to measurement and classification error. Hence, the econometric method should characterize tendencies which do not depend on slight changes in the definition of "activity". Fourth, the econometric approach must use methods which are potentially robust to missing determinants, as well as different data sets.

Since this is the first analysis of this data, it focuses on questions which characterize basic patterns. Below I employ and contrast two related approaches:

! **A trivariate probit between the three complementary services:** Let Y_{ni}, Y_{hi}, are Y_{wi}, be determined by distinct but related processes. Accordingly, there are three continuous latent variables, Y^*_{ni}, Y^*_{hi}, and Y^*_{wi}, which determine the choices to perform each of these non-basic activities. Let $Y^*_{ni} = a_i +$

[18] It is also possible to coarsely measure whether an ISP offers any service, offers a few simple variations on it, or offers many different services. For reasons discussed below, these were not useful.

$X_iB_n + e_{ni}$ describe the latent variable. Let similar relationships hold for the other two activities. Here a is a random variable which is common to each activity but varies across ISPs within the panel. This captures an underlying and unobservable disposition to perform non-access services, reflecting underlying demand, entrepreneurial vision and competitive conditions which are common to different activities at the same ISP.[19]

! **A bivariate probit between frontier access and the complementary services:** Let the endogenous variables reflect values shown in Table 2. For frontier access let Y_{fi} equal one if the ISP offers frontier access, and zero otherwise. For the other variable, an ISP gets a value of one if it offers at least one complementary service among networking, hosting and web design. More precisely, define $Y^*_{ci} = 0$ when Y_{ni}, Y_{hi}, and Y_{wi}, all equal zero. In all other cases $Y^*_{ci} = 1$. Let Y_{fi}^* be the latent endogenous variables. Then let $Y^*_{fi} = a_f + X_iB_f + e_{fi}$ and $Y^*_{ci} = a_c + X_iB_c + e_{ci}$, where a_f and a_c are potentially correlated.

Both approaches focus on understanding the determinants of each service. After considerable exploration in early versions of this study, it was found that most of the importance of different determinants can be characterized with these two straightforward models.[20] Future work will explore related questions associated with the incentives to perform different combinations of activities and the capacity of local markets to only support a maximum number of entrants.[21]

B. Exogenous variables

A full explanation for each variable is included in Appendix II.

! The *firm specific factors* generally measure attributes that tend to cluster together, partly due to economies of scope and partly due to firm focus on particular markets. EXPERIENCE is a dummy which takes on a value of one if the ISP was listed in *thedirectory* in the spring of 1997, more than a year earlier than the survey in *thelist.* Since there were roughly two thousand new entrants in 1997 and 1998, this

[19] Note that the correlation of the errors in this setting is, at best, only a weak "test" of whether the services offerings are complementary (see e.g., Athey and Stern [1998] for discussion).

[20] Early versions of this study explored many variations on these specifications with little additional insight. Early version also examined the extent of non-basic access activity, counting the number of different services an ISP offered. I estimated both ordered probit and a negative binomial models. The results resembled the "any service" side of the bivariate probit. Hence, I show the simpler econometric results.

[21] Downes and Greenstein [1999] do take this approach to understanding ISP entry, but this paper cannot use the same approach since, due to concerns about accuracy, this paper uses a data set which is an incomplete census of all the ISPs who offer new services.

dummy measures whether a firm was an early entrant into the ISP business. COMMUNICATIONS and COMPUTER take on the value one if the ISP lists another line of business related to non-TCP/IP based communications/computers (e.g., typically a retail outlet for purchases or service). MISCBUSINESS takes on one if the ISP maintains another non-TCP/IP business line (e.g, retail outlet for photocopies or a cafe). HANDHOLDING measures whether an ISP is trying to make basic access technology (e.g., e-mail, filtering, downloading, name registration) easy to use for some of its customers. It counts the number of times an ISP advertises its ability to do these simple things (see Appendix III for precise definition). Since these were activities which a technical user already understands, an ISP did this to attract a non-technical customer. DIALUP takes on the value one when an ISP offers any dial-up service; its absence indicates an exclusive focus on business customers. DEDICATED takes on one if the ISP offers any direct access; its absence indicates an exclusive focus on residential customers.[22] The geographic reach of an ISP is measured in two ways. ONEAREACODE takes on the value one if the ISP maintains service in only one area code, as indicated in *thelist*.[23] An additional measure of size, ONECOUNTY, takes on the value one if the ISP maintains service in only one county, as indicated in *thedirectory*.

! *Location-specific factors* are exogenous to the firm. Early specifications included variables similar to those found in Augereau and Greenstein [2000], which examined a different sample of ISPs and their upgrade behavior from a year earlier. This included measurement of demographic features of areas, infrastructure, competitiveness and the presence of universities in the county in which the ISP provides service. In early estimates many of these were not statistically different from zero, mostly due to multi-collinearity with other location-specific variables in this data-set. For brevity, these coefficients are dropped in favor of URBAN and FRACPROF. See the Appendix II for detail.

URBAN reflects the percentage of urban counties in which the ISP offers local dial-up service or

[22] Both DIALUP and DEDICATED are, arguably, endogenous from an econometric standpoint, as these are decisions which may have been made at the same time as the decisions to experiment in frontier access and complementary services. To test whether the estimates are sensitive to their inclusion, I tried specifications with and without them and found that the estimates did not dramatically change. Hence, I only show the estimates with these variables included.

[23] When examining the entire data set, where location-specific data is not available, I also use MORETHAN20, a dummy variable for presence in more than 20 area codes, indicative of national coverage. See Appendix I estimates for entire sample. However, as noted in Downes and Greenstein [1999], national coverage necessarily implies that the ISP has located its POPs in urban areas; that is, virtually every national ISP offers services in the top 50 cities of the US. Thus, there is little (measurable) geographic variation between large firms and little variation in local conditions.

maintains a headquarters. URBAN, by itself, supports several interpretations. This variable is not identifiably different from local market competitiveness, density of available customers for a fixed firm size, and the quality of local infrastructure – i.e., ISPs in urban markets face more competitive settings, can reach more users for the same investment, and generally have access to better infrastructure. Next, FRACPROF describes the fraction of the population in white collar work (see Downes and Greenstein [1999]). This ostensibly measures local differences in demand, though, once again, this variable supports several interpretations. FRACPROF is not identifiably different from other demographic measures in a region. Areas with higher FRACPROF tend to have populations which have higher income, more education, more white-collar work and more PCs at home and at work.

! **The distribution of factors between urban/rural locations:** FRACPROF coincides partially with urban/rural in that it has a mean value of .41 for ISPs in urban counties, and a value of .32 for ISPs in rural counties. This is quite interesting since it can identify urban/rural differences which arise due to demand instead of other factors, such as competitiveness and density.[24]

A related pattern also arises in some of the firm-specific variables. There is more hand-holding in urban ISPs (1.03 vs .64 on average), more experience with computing (.01 versus .006), and more experience with other business (.012 versus .008). There are also differences in dedicated investments (.90 versus .93). These differences raise the possibility that the distribution of firm-specific factors among urban/rural areas will explain behavior instead of the urban/rural variable by itself.

This discussion also motivates a similar comparison between the general features of the firm-specific variables for the local ISPs in urban areas and larger ISPs, who are excluded by design. Larger ISPs locate most of their points of presence in urban areas. Interestingly, no differences were found between the firm-specific variable means or variances for large ISPs or small ISPs in urban areas. This suggests that some of the inferences about small ISP in urban areas may apply equally well to large ISPs who are otherwise similar and located in similar urban areas.[25]

6. Results

[24] These populations do not differ in the standard deviations (both are approx .055), but they do differ in their minima (.17 vs .22) and maxima (.49 and .59).

[25] Additionally, it suggests that differences in the coefficient estimates for URBAN and national presence are informative about the effect of size on ISP behavior. See Appendix I for estimates for entire sample.

Table 4 presents estimates for the models. The first, second and third columns are the trivariate model and the last two columns are the bivariate probit.

The absence of a dial-up capability reveals an ISP that focuses on a business market, while the absence of a dedicated capability reveals an ISP who focuses on a residential market. Hence, to avoid including perfect predictors of frontier access (i.e., no business focus = no frontier access) and complementary services (i.e., no dial-up = complimentary service), DEDICATED is dropped from the frontier part of the bivariate probit, and DIALUP is dropped from the complimentary side of the bivariate probit and all the estimates in the trivariate probit.

In addition, earlier specifications tested whether the reporting date on *thelist* influenced results and found no evidence of any reporting bias.[26] As it reduces the sample size, it is not reported in the specification.

A. Description of findings

DIALUP is negative in the frontier part of the trivariate probit, as expected. The absence of a commercial dial-up service indicates a business focus and a high likelihood of offering frontier direct access business services. It is a large estimate; only one other dummy variable predicts as well (see below). However, only 2% of the sample has no dial-up capability, so it is a good predictor for only a small number of cases. DEDICATED is positive and significant in the complementary activity part of the bivariate, indicating that the investment in some dedicated capabilities predicts more new services. It particularly matters for networking and web design, but not hosting. Since almost 10% of the sample has no dedicated capability, it is a good predictor for a relatively large number of cases.

HANDHOLDING is a positive and significant predictor of new services including frontier access. However, HANDHOLDING is qualitatively unimportant in the frontier probit, consistent with the interpretation that it captures the marketing focus of the ISP and not just its propensity to "talk." HANDHOLDING matters for all the complementary services, with slightly higher estimates for hosting services. As its mean value is close to one, variance in HANDHOLDING is not too important except at extreme values. HANDHOLDING is a qualitatively important predictor for the 10% of ISPs with values

[26] *Thelist* requires the ISP to provide the day of its last update. Some ISPs clearly update their information frequently, while a few had not done so in over a year. I tested for whether the most recently reported information contained more reported services, even controlling for other factors, and found no evidence of such.

above 3 . In other words, firms who are willing to make the effort to extensively explain even their basic access services are more likely to also offer complementary services. This is good evidence that many commercial firms are consciously trying to bridge the gap between the technical frontier and the needs of the less technically sophisticated commercial users.

The related lines of business predict an ISP willingness to experiment with new Internet services. COMMUNICATIONS, COMPUTERS, and MISCBUSINESS are positive statistically significant coefficients on one half of the bivariate probit but not the other. Only COMMUNICATIONS matters for the frontier side of the probit. In other words, experience in any other line of business is a good predictor of more new services in at least one type of complementary service, but only business in communications influences experimentation with high speed access. This is consistent with expectations and quite sensible. The trivariate probit reveals some interesting differences among the three complimentary services. All three factors predict the offering of networking services, COMPUTERS and MISCBUSINESS predict web design, only COMPUTERS predicts the offering of hosting.

COMPUTERS is more than twice as large as either of the other two dummy variables in the bivariate estimates, while COMMUNICATIONS contributes much more to providing frontier access. COMPUTERS particular contributes to the offering of networking services and web design services. Again, this is consistent with expectations, a firm (or entrepreneur) that was selling or repairing PCs before the commercialization of the Internet is quite likely to expand their business into basic Internet access and related lines of services, such as network maintenance, hosting and web design, but not necessarily high speed access. The one limit to all these inferences is that COMPUTERS, COMMUNICATION and MISCBUSINESS take on values of one for only a small percentage of the ISPs, so their predictive power only works for a small part of the sample of ISPs. This finding is consistent with an important role for previous experience linked to the experience of a firm in a particular product market.

The coefficient on EXPERIENCE is insignificant in all estimates except the estimates for networking. Even in that case the coefficient is not very large (.22), so time in business is not an important factor in this market.

ONEAREACODE is a negative predictor of experimentation in all estimates, though the estimate is never large. ONECOUNTY suggests some interesting qualifications to that conclusion. An ISP who is in only one county is even less likely to offer frontier access. Together these are large (-.58-.18=-.76), reinforcing the importance of size as a predictor of offering this service. This result contrasts with the

estimates for complementary services. The trivariate probit shows that ONECOUNTY makes an ISP more likely to offer networking services. The coefficient is not very large (.21), so it is only weak evidence of the possibility that local-specific factors may influence some repair and maintenance services for networking. ONECOUNTY is not different from zero for hosting or web design.[27]

The estimate of URBAN is not significant except in the networking probit, and even this coefficient is not very large (.16). These are striking estimates because they contradict the hypothesis that URBAN location induces entry into frontier access. Moreover, they differ from the simple inference done with the unconditional data.

Along with ONECOUNTY, the coefficient on URBAN is, at best, weak evidence that the provision of networking differs from hosting and web-design. More concretely, an early entrant (EXPERIENCE=1) into the ISP business who is only located in a single (ONEAREACODE=1) urban (URBAN=1) area is also likely to be in only one county (ONECOUNTY=1).[28] It is more likely to offer networking services (.21+.22+.16-.28=.31) than an inexperienced, rural ISP that is spreading service among counties and area codes. Yet, at best, this is weak evidence of a difference between networking and the other complementary services due to the small coefficient estimates.

The evidence for the importance of location-specific factors is mixed at best. FRACPROF is statistically significant in the estimates for frontier access, networking and web design, but not hosting. However, the size of the coefficients is relatively small. Only large swings in the exogenous variables, on the order of several standard deviations, influence any of the results to an important degree. In other words, an ISP located in an area with an extremely high fraction of professionals (e.g., .50), as compared with an ISP in an area with a extremely low fraction (e.g., .25), is more likely to offer frontier access (.25*1.37=.34), web design (.40), and especially networking (.62). This is important, to be sure, but only at the extremes. Thus, it is not especially strong determinant for most of the sample.

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[27] To further test for importance of location on size, scale and density effects, URBAN was interacted with ONECOUNTY and ONEAREACODE. That is, an ISP in one urban county can reach more people than an ISP in one rural county. Also, an ISP in one urban area codes covers a smaller geographic territory than an ISP in one rural area code. This re-specification mildly influenced the estimates, showing that small ISPs in urban areas were more likely to offer frontier access than small ISPs in rural areas. However, it did not lead to any other inferences for the other services. Hence, the simpler specification is shown.

[28] One area code is a good predictor of one county. 88% of the 1067 ISPs in one area code are only in one county. Naturally, the converse is not as strong. Because most major dense urban areas have multiple area codes, only 56% of the 1658 ISPs in one county are in only one area code.

B. Overall Assessment

The estimates for the original sample strongly suggest that frontier access and other activities are not similar. The estimates lead to a sound rejection of $B_f = B_c$ in the bivariate probit, consistent with the modeling decisions to treat these two decisions as interrelated but seperate. The estimate for the correlation coefficient reinforces this conclusion. It is 0.12 in the bivariate probit, indicating a small positive relationship between the unobserved determinants of experimentation.

Such a strong rejection is not possible between the three complimentary services. All three share some similar estimates in terms of signs and economic significance, though these similarities are stronger between networking and web design than between hosting and the other two. In other words, it is not possible to reject $B_n = B_w$ for most of the coefficients, while it is possible to reject a similar test for a subset of coefficients associated with hosting and the other two services, i.e., $B_n = B_h$ or $B_w = B_h$. The estimated correlation of errors contains further information about the similarities in services. In the trivariate probit, the correlation between the unobserved error in the networking and hosting probit is .16, between hosting and web design .32, and between networking and web design .58. Indeed, .58 is so high as to raise the question of whether the industry's propensity to discuss these services as distinct is relevant as an empirical matter. However, enough differences emerged (i.e., EXPERIENCE, COMMUNICATION, ONECOUNTY, URBAN, and FRACPROF) to suggest weak evidence of differences between the determinants of these services.

From this analysis several conclusions arise. First, there appears to be significant ISP-specific factors which cluster together with the choice to offer new services. In particular, size, geographic scope, key capital investments, focus on particular types of users and non-ISP lines of businesses all predict experimentation with new services. Second, frontier access is distinct from any other type of differentiation, and is weakly influenced by location-specific factors. Third, while hosting is more similar to the other services than frontier access, it also has several differences, mostly importantly that it is influenced by few location-specific factors. Fourth, networking and web design services have many similar observed and unobserved determinants, and both appear to be weakly influenced by location-specific factors. This seems to indicate a weak tendency for hosting and frontier access to become national products, while, in contrast, networking and web design may retain a structure with both some national and some local suppliers.

In general, variations in location-specific variables are not as important as variation in firm-

specific variables across all the services. Variables measuring other location-specific features, such as FRACPROF and URBAN, do influence behavior, but in only a few instances. However, some of the firm-specific variables – whose distribution does vary over geographic space – does help explain some of the observed variance. This includes HANDHOLDING, COMPUTING, MISCBUSINESS and DEDICATED.[29]

These findings are consistent with the view that small ISPs choose strategies for differentiation based on firm-specific growth strategies, limited (possibly) by non-convexities arising at a local level. Basic service has some scale economies arising from capital equipment investment and other fixed costs on the back end, but these scale economies are not severe because small ISPs rely on existing telecommunications infrastructure. In contrast, frontier access is scale intensive, requiring higher volume of use and, therefore, is not profitable without a density of potential users, typically businesses, a situation prevalent in urban areas and only a few rural areas. Networking, hosting and web design require a core mass of business customers to defray the costs of acquiring capital and maintaining sufficient technical expertise. These costs are also defrayed by some economies of scope among these services and between these and other lines of business.

These observations suggest the industry may obtain a bifurcated size structure in the long run. Many observers forecast consolidation around a few national providers who find economies of scale in a national service, perhaps consistent with the presence of endogenous sunk costs ala Sutton [1991]. However, small ISPs appear to be finding some economies of scope between Internet access and another line of service, especially one with local elements such as high-speed access or networking service. These findings suggest that national service and local service may remain imperfect substitutes in the eyes of users. In that case, the industry could retain a mix of local and national firms.

C. Differentiation, Density and the Growth in Evolving Markets

The structure of the ISP business is shaped by the geographic diversity of local markets and the heterogeneity of firms who commercialize that technology. This dispersion shapes the customization of technology to new users and established businesses. This process is a source of great policy concern

[29] The data of all 3816 ISPs also finds a large firm bias, consistent with this theme. National coverage and the large size tend to put firms in urban areas.

(Werbach [1997], Esbin [1998], Weinberg [1999]), as this relationship shapes the creation and targeting of subsidies associated with new services, such as the E-rate program, as proposed in the 1996 Telecommunications Act.[30]

While this data tends to support the view that there is a lower propensity for new services in low-density areas, any conclusion has to be carefully drawn. While the unconditional data document a difference in the propensity in urban and rural ISPs, the conditional estimates found a less stark relationship. The estimates highlight the importance of several distinct factors which produce geographic dispersion of outcomes.

Urban areas get more new services because of two factors: (1) increased exposure to national ISPs, who expand their services more often; and (2) the local firms in urban areas possess features that lead them to offer services with propensities similar to the national firms. That is, high density areas almost always get some ISP entry, while some low density areas get none or very little. High density areas see an especially large amount of entry because they experience entry from nearly all the firms with national ambitions. While little or no entry in a low density area virtually precludes availability of any complement to basic access, high density areas benefit from repeated exposure to many ISPs who offer such services. More entrants will lead to more realized numbers of new services, raising the probability of finding one, two or three instances of new services in a specific location.

This is particularly evidence in the case when ISPs in urban areas have higher propensities to offer services, as in this data, because ISP-specific factors are not distributed independently of geography. There is more hand-holding in urban ISPs, more experience with computing, more experience with other business, as well as differences in dedicated investments, and differences in the fraction of the population which is professional. Except for the estimates for the propensity to offer networking, these other *observed* factors explain the observed difference better than a simple urban dummy.

Yet an important caveat applies. The above models also estimate positive and statistically

[30] If the lower propensity to find new services in low-density areas is due to an absence of local firms with appropriate skills, then policies might either induce ISPs to expand from high-density areas to low density areas (where they would not otherwise be), or it must induce incentives/vision/investments from ISPs who are already located in low-density areas (but who would otherwise not choose to offer such services). If, on the other hand, the absence of new services in low-density areas is due to an absence of local demand for these services or the absence of local infrastructure, subsidies run the risk of not changing the propensity to experiment in such areas. Indeed, in that case, the subsidy will be wasteful if it induces the offering of services which few want.

significant correlations between the *unobserved* determinants of the ISPs' propensity to offer services. This estimated correlation can be a function of unobserved ISP-specific determinants of both activities or unobserved location-specific determinants of both activities. There is no way to tell which it is. Thus, it is possible that some of the unconditional differences in the propensity to offer services in urban/rural settings results from these unobserved location-specific factors.[31] Only if the correlation was zero – which it is not – could we rule out the role for location-specific factors completely.

These observations also raise a related and subtle question. The above econometric study is conditional on entry of an ISP in the first place, treating the ISP's features and its region as statistically exogenous. Yet, entry might be a function of some unobserved and historical matching process between the individual employees and founders of the ISP and the local area. For example, low density areas have fewer entrants altogether, leading to fewer providers of access with the ISP-specific factors which lead to non-basic services, resulting in fewer new services. This observation does not undermine the conclusions above about the relative importance of ISP-specific factors over location-specific factors; it simply begs the question about whether the presence of some ISP-specific factors are exogenous in some dynamic and long run sense. There are a number of ways for this process to work. For example, it is possible that ISPs who were more inclined to expand (in 1998) decided to locate in urban areas (in 1996, say) in order to have that option later. This type of decision making could induce the geographic dispersion of ISP-specific factors seen in this data.

Hence, it is appropriate to be cautious about inferring causality between firm specific factors and new services. The tendency of firm-specific factors to cluster together can also result from the presence of an unobserved third variable, such as entrepreneurial ability, causing both the endogenous and exogenous variable to move together.

6. Conclusion

Many technology enthusiasts have been waiting for the on-line revolution for a long time, welcoming the possibilities for new businesses, new services and new types of communications. Now that it is here, a commercialized Internet may not be precisely what they had in mind. The economic benefits

[31] A number of factors cannot be ruled out, such as location-specific spillovers across vendors, location-specific learning about demand, and other factors operating on a small geographic level.

associated with new frontier technologies are diffuse, uneven and uncertain. Commercializing the Internet is difficult and adaptation is time-consuming. Many new services do not employ frontier technology at all. Indeed, much commercialization involves bending basic technology to the needs of unsophisticated users, a process that often involves many non-technical issues. Some locations have access to the latest technology from commercial firms and some do not, creating the potential for a digital divide in the provision of services.

Commercializing Internet access gave rise to new business models, new cost structures and new applications. Like any other economic activity, not all firms were alike. Providing access involved a mix of the general technical capabilities and specific circumstances facing a particular firm in a particular place. ISPs customized Internet technologies to the unique needs of users and their organizations, solving problems as they arose, tailoring general solutions to idiosyncratic circumstances and their particular commercial strengths. Sometimes ISPs called this activity consulting, and charged for it separately, sometimes it was included as normal business practices. In either case, it involved the translation of general knowledge about Internet technologies into specific applications which yielded economic benefits to end-users. In all cases differences between their offering and their nearest competitor raise returns to innovative activity, inducing a variety of services from different ISPs.

Viewing the Internet access market in this way helps provide empirical guidelines for understanding the variety of new services. Some services were shaped by previous ISP experience, while others were mildly responsive to local conditions. The factors which lead small ISPs to offer new services, such as large geographic scope, previous investments and strategic focus, are disproportionately found in urban areas.

This study raises questions about the nexus of industry evolution and organizational change. Will this industry retain its structure of small and large firms? How do the economies behind combinations of new services evolve as firms grow, add capital structures and alter their pricing strategies? Do hand-holding activities emerge from investments by firms and how does the local labor market for related activities, such as computer services, foster its growth? These issues cannot be understood without further work on the fundamentals of demand and organizational change in Internet activities.

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Table 1
Product lines of ISPs

Category definition	Most common phrases in category	Analysis Sample*
Providing and Servicing Access though Different Channels	28.8, 56k, isdn, web TV, wireless access, T1, T3, DSL, frame relay, e-mail, domain registration, news groups, real audio, ftp, quake server, IRC, chat, video conferencing, cybersitter TM	2089 (100%) *Rural ISPs 325 (100%)*
Networking Service and Maintenance	Networking, intranet development, WAN, co-location server, network design, LAN equipment, network support, network service, disaster recovery, backup, database services, Novell Netware, SQL server	440 (21.1%) *Rural ISPs (11.0%)*
Web Site Hosting	Web hosting, secure hosting, commercial site hosting, virtual ftp server, personal web space, web statistics, BBS access, catalog hosting	460 (22.0%) *Rural ISPs (13.8%)*
Web Page Development and Servicing	Web consulting, active server, web design, java, perl, vrml, front page, secure server, firewalls, web business solutions, cybercash, shopping cart, Internet marketing, online marketing, electronic billing, database integration	757 (36.2%) *Rural ISPs (23.3%)*
High Speed Access	T3, DSL, xDSL, OC3, OC12, Access rate > 1056k	514 (24.6%) *Rural ISPs (12.0%)*

*Unit of observation is an ISP in a small number of territories. See text for precise definition. Top number is for all 2089 ISPs in analysis sample. *Italicized* percentage is for the 325 ISPs found primarily in rural areas.

Table 2
Product lines of ISPs

		Network, Hosting, & Web Design		
		Offers	Does not	Total
High Speed Frontier Access	Offers	314 (15%)	200 (10%)	514
	Does not	736 (35%)	839 (40%)	1575
	Total	1050	1039	2089

Table 3
Descriptive statistics for the analysis sample
2089 Observations

	MEAN	STD DEV	MIN	MAX	SOURCE*
EXPERIENCE	0.712	0.453	0.000	1.00	*Thedirectory*
COMMUNICATION	0.009	0.095	0.000	1.00	*Thelist*
COMPUTERS	0.034	0.182	0.000	1.00	*Thelist*
MISCBUSINESS	0.009	0.092	0.000	1.00	*Thelist*
ONECOUNTY	0.794	0.405	0.000	1.00	*Thedirectory*
ONEAREACODE	0.511	0.500	0.000	1.00	*Thelist*
DEDICATED	0.905	0.293	0.000	1.00	*Thelist*
DIALUP	0.984	0.127	0.000	1.00	*Thelist*
HANDHOLDING	0.973	1.352	0.000	11.00	*Thelist*
URBAN	0.836	0.360	0.000	1.00	D&G, Census
FRACPROF	0.397	0.066	0.176	0.60	D&G, Census

* *Thedirectory* is www.thedirectory.com. *Thelist* is www.thelist.com. Census is the US Census. D&G is Downes and Greenstein [1999].

Table 4
Estimates for Trivariate and Bivariate Probit models
2089 ISPs
Standard Errors below Estimates in Italics

	Trivariate Probit						Bivariate Probit			
	Network		Hosting		Web		Frontier		Three Activities	
EXPERIENCE	0.23	**	0.00		0.01		-0.04		0.11	
	0.08		*0.07*		*0.07*		*0.07*		*0.07*	
COMMUNICATION	0.69	**	-0.01		0.03		0.76	**	0.34	
	0.34		*0.34*		*0.34*		*0.30*		*0.40*	
COMPUTERS	1.17	**	0.43	**	0.91	**	0.19		1.21	**
	0.15		*0.15*		*0.16*		*0.16*		*0.19*	
MISCBUSINESS	0.71	**	0.23		0.69	**	0.00		0.50	*
	0.31		*0.35*		*0.34*		*0.38*		*0.30*	
ONECOUNTY	0.21	**	0.10		0.02		-0.18	**	0.13	*
	0.09		*0.08*		*0.08*		*0.08*		*0.08*	
ONEAREACODE	-0.28	**	-0.08		-0.22	**	-0.58	**	-0.21	**
	0.07		*0.07*		*0.06*		*0.07*		*0.06*	
DIALUP							-1.00	**		
							0.24			
DEDICATED	0.50	**	-0.08		0.36	**			0.20	**
	0.14		*0.11*		*0.10*				*0.10*	
HANDHOLDING	0.16	**	0.26	**	0.19	**	0.04		0.35	**
	0.02		*0.02*		*0.02*		*0.02*		*0.02*	
URBAN	0.16	**	0.02		0.01		-0.02		0.07	
	0.07		*0.08*		*0.07*		*0.07*		*0.07*	
FRACPROF	2.48	**	0.23		1.60	**	1.37	**	1.42	**
	0.59		*0.54*		*0.50*		*0.54*		*0.50*	
Constant	-2.79	**	-1.15	**	-1.47	**	0.13		-1.20	**
	0.29		*0.25*		*0.23*		*0.33*		*0.23*	
Rho							0.14	**		
Frontier, Activities							*0.04*			
Rho	0.16	**								
Network, Hosting	*0.04*									
Rho	0.58	**								
Network, Web	*0.03*									
Rho	0.32	**								
Hosting, Web	*0.04*									

Presence of ISPs in analysis sample