Valuing the net: What Determines Prices for Dial-up Internet Access?

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PRELIMINARY, INCOMPLETE AND NOT FOR QUOTATION.
Comments welcome.

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Abstract

This study examines quotations for over 4000 price schedules for Internet dial-up service at over 2000 Internet Service Providers (ISPs) from the fall of 1998. This study analyzes why prices differ at the same ISP and across ISPs. The most important determinants of prices are contract length, contract hour limitations, how the ISP arranges its entire menu of prices, business/household differences in the contract bundle and the date the pricing contract is offered. There is circumstantial evidence that the density of the location of the ISP influences price levels. There is plenty of evidence of price discrimination, but much of it is consistent with the presence of competitive pressure. The best evidence that market power shapes some pricing decisions in this market arises in rural markets, which makes up a small fraction of the sample. The paper develops implications for conducting price measurement in Internet access markets and for understanding contracting practices in data communications markets.

1. Introduction

This study examines quotations for over 4000 price schedules for Internet dial-up service at over 2000 Internet Service Providers (ISPs) from the fall of 1998. This study analyzes why prices differ at the same ISP and across ISPs. Since it is the first study to ever examine pricing in this market, the study begins by documenting the substantial dispersion in prices. It then develops a framework for sorting between potential determinants of price levels.

These prices are interesting to examine; these are the prices paid by most households and unsophisticated users, i.e., the mass market. Close to a third of US households had contracted with an ISP for dial up service by this time. Access enabled users to use free Internet services, such as news, entertainment, chat and other forms of brochure-ware. At this time few Internet-related activities collected significant revenue, but Internet access was an important exception, reaching revenue in excess of five billion dollars in the dial-up and direct access markets together (Maloff, 1998). To be sure, a high fraction of businesses were integrating their operations with the Internet, but these changes were far from mature. Internet retailing also was unproven, not particularly large nor profitable by this time.

These study examines three types of determinants of prices: features of the contracts for ISP service, features of the ISPs offering the service, and features of the location in which the ISP offers service. The study shows that there is an important link between contracting practices and pricing levels. The most important determinants of prices are contract length, contract hour limitations, how the ISP arranges its entire menu of prices, business/household differences in the

contract bundle and the date the pricing contract is offered.

The paper also explores the relationship between the ISP's characteristics and its pricing. There is a little evidence that economies of scale influence price levels, but it is not strong. There is no evidence of economies of scope between access prices and related Internet services. Many functions which users desire (and which ISPs feature prominently in their marketing) do not explain differences in prices, with the possible exception of games and faster transmission speeds.

Finally, there is a link between an ISP's location and its pricing. First, pricing levels vary over density and so do types of ISPs. ISPs in urban areas have better transmission facilities, which accounts for a part of the difference in urban/rural prices, but not all. Second, circumstantial evidence indicates that competitive conditions in a location influence the choice of pricing strategies. Interestingly, there is plenty of evidence of price discrimination, but much of it is consistent with the presence of competitive pressures. The best evidence that market power shapes some price discrimination arises in rural markets, which makes up a small fraction of the sample's prices.

This study informs several different literatures. First, it seeks to identify principals for measuring the value of the economic activity, an unsettled topic for price research about Internet related services. This case is novel since only one other paper has examined the pricing of Internet access services and none has done so with as much detail about contracts and ISPs.[2] The task is also challenging because flat rate pricing is common in this industry; this practice frames several challenges described below. In addition, the industry is young, innovative and changing

[2] Citation to the price index for Canadian ISPs...

rapidly, a situation which typically defies easy classification using standard principals for economic measurement. Constructing either a producer or consumer price index for such an industry is generally quite difficult; pricing research can identify key issues and puzzles.

Second, the paper departs from the typical study of price dispersion.[3] As with those studies, the general purpose of this study is to sort between a variety of potential explanations and highlight open puzzles. Explanations vary between those which emphasize factors related to the costs of providing service, and those related to the ability of suppliers to use their market power to price discriminate. That said, this study has more in common with empirical studies of contracting.[4] This is partly out of necessity, since the study examines extensive information on the menu of potential prices offered by ISPs. However, this turns out to be quite advantageous, since it helps identify a previously unknown association between price levels and types of contracts, while controlling for other factors associated with an ISP's quality and its location.

Third, this study sharpens the understanding of flat rate pricing, a practice that arises frequently in regulated local land-line voice telephony and occasionally in unregulated cellular telephony. Flat rate pricing arises in this market for three reasons. First, most dial-up Internet access operate over local phone switches where per-minute use is not metered. Hence, local ISPs do not incur any costs from offering the user unmetered service, letting the user continue to have flat rate Internet service over the local phone line.[5] Second, as a matter of engineering, it is not

[3] Citation to recent price discrimination studies, such as Shepherd, etc.

[4] Citation to review of empirical contracting literature, such as Masten's book.

[5] As has been widely noted, this situation contrasts sharply with European countries where per minute phone service is metered. In those situations some ISPs have found it advantageous to incur some of the phone

easy to monitor data-flows for each user during different times of the day, so it is costly to implement something other than flat rate pricing at the level of the user. Third, competitive pressure has forced many ISPs to adopt unlimited usage for a monthly price. That is, many users simply prefer the practice and prefer ISPs who use it.

Accordingly, flat rate pricing has not gone unnoticed by economists.[6] Many theoretical models have explored the consequences of this feature for ISP conduct and capacity use. There also have been a few experimental attempts to apply different principals, borrowed from the well known literature on peak-load pricing, to Internet use in a laboratory setting.[7] However, no study has performed a census of empirical variants of flat-rate pricing used by ISPs, nor ISPs departures from it, nor their determinants. This is a big gap in the literature. This is precisely what this study addresses.

Finally, this study follows a small but growing list of recent studies which argue that the "new economy" has familiar rules.[8] In this study the ISP is viewed as a special player in the mass market for communication services, acting as the commercial gateway to a large fraction of the activity associated with the web. Pricing conduct informs our understanding of user's willingness to pay for access to the Internet and it particularly informs our understanding about the private ability to supply this service. Is there something special about the conduct in one of the few places

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charges in order to encourage Internet use.

[6] Even the general business press has noticed. AOL's reluctant and late adoption of the practice received tremendous publicity because AOL was unprepared for the expanded use of its facilities.

[7] For reviews see Mackie-Mason and Varian, McKnight, Whinston...etc.

[8] Citations to Brynolfsson, etc.

in the early Internet industry where users actually gave up money? This paper argues that there is not. The study largely uses mainstream economic concepts and models to successfully characterize ISP or market behavior, even though such behavior is heavily embedded in Internet technology.

2. Background and hypothesis

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. There is both a supply and demand for the commercial organizations who provide access to Internet technology. This section explains the basic factors shaping supply and demand and how these influence pricing.

A. Key Features of Supply in 1998

In brief, the NSF officially commercialized the Internet around 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 universal resource locator and hypertext markup language (URL and html). Browser software began diffusing widely in 1993

beginning with Mosaic, the ancestor and model for Netscape, Internet Explorer and other browsers.

Commercial Internet Service Providers began emerging in 1994 (Boardwatch, 1994), employing technical refinements developed over many years at academic modem pools and commercial bulletin boards.[1] 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 ISPs were devoted primarily to dial-up. However, this changed as the industry grew at an explosive pace. 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 services associated with 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).

By the time of this study AOL, AT&T, Mindspring/Earthlink, and many other ISPs, each focused on building a large national presense, investing heavily in capital and marketing expenditures. Other ISPs, such as those with a regional or city specific focus, deliberately concentrated on new services, such as network development and maintenance, which enhanced their marketing advantages at a local level. AOL had signed up approximately half of the households who had adopted in the US, while the reminder of households used a wide variety of providers. By the time of this study, AOL had abandoned marginal pricing of many services, moving to flat rate pricing, which was widely regarded as the norm for dial-up service at most other ISPs.

[1] Greenstein [2000c] contains an analysis of the factors influencing the growth of this industry.

A simple dial-up service was inexpensive to operate and a web page was quite easy to develop. Providing basic access required a modem farm, one or more servers to handle 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. Hence, many entrepreneurs took to the technology. So too did many personnel from incumbent firms in related markets, such as bulletin board operators and computing services personnel. As it turned out, even a small provider could survive on a few thousand (or sometimes fewer) subscribers. Therefore, thousands of ISPs entered the market.

For an ISP who owned and operated its own facilities,[3] three distinct economic constraints guided the cost structure of providing service at a point of presence, a location which ISPs developed for users who phoned for access. To over-simplify, these are: modems, backbone and customer acquisition/retention. These three costs go far in explaining pricing behavior.

First, modem capacity provided a limit on the maximum number of phone calls at any point in time at a point of presence. Costs for modems were mostly sunk once expended, with a few variable expenses associated with increasing capacity and with occasional maintenance expenses and equipment failure. During this era many users were in the midst of upgrading or

[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.

[3] Many geographically small ISPs also rented phone numbers for facilities in other locations, which also introduces additional considerations when pricing national service. This discussion will describe the simplest case to develop key concepts.

expanding their modem banks from 28.8K to 56K speeds, so many ISPs made related investments. By the end of 1998 high speed modem banks were a necessity for most ISPs.

Second, backbone connections were another constraint on the maximum flow of data. If capacity was reached, it translated into slower connection speeds for users. Users experience poor quality backbone connections in the speed with which web pages downloaded, a feature of value to most users. The determinants of data flows were complex and varied significantly across ISPs. Data flows are positively correlated with number of users but the correlation is weak. Many factors matter in practice. Users differ greatly in their usage patterns -- i.e., web surfing tends to bring in more data than it sends out, email is not data intensive, etc. Costs for backbone connections were mostly determined by contracts with providers such as UUnet, usually on a one-to-three year basis. These contracts covered total capacity and often contained provisions about priorities in the event of capacity constraints. Hence, backbone expenses are largely sunk once contracts are signed, but variable in the long run as capacity is adjusted. Some performance criteria in these backbone contracts can influence user experience under some circumstances.

Third, customer acquisition and retention activity influenced the ISP cost structure. In an era of first-time adoption and frequent turnover, such as 1998, average costs of providing access services were quite sensitive to user exit. The trade press reported many different estimates of "customer acquisition and retention costs", the average marketing expenses needed to acquire new long-term customers or hold on to an experienced one. Given the volatility of the young market, there were widely different reports about what, in fact, succeeded -- i.e., whether the key to attracting and retaining lucrative customers lay in advanced web services for experienced users,

friendly hand-holding for new users, deals for national presence on one's own or another ISP's facilities, and other kinds of marketing gimmicks. These administrative/marketing expenses were largely sunk once expended, but were variable in a forward-looking sense, since they grew with increases in number of users. A key observation was that the cost of retaining a customer was generally cheaper than the costs of acquiring a new one.

There were also many other fixed costs to running an ISP, associated with security, support, maintenance and monitoring of facilities. There were also many optional expenses associated with the quality of service, such as whether to invest in extensive hosting facilities, downloadable shareware, links to sites of local interest and so on. In addition, other variable costs began to play a role if the ISP aspired to become a national provider, such as the coordinative activity associated with running a dispersed network. Where relevant for pricing, these will be highlighted below.

B. Demand for Internet Access

By 1998, surveys showed that no more than 10 percent of Internet user at US household got their Internet access from university-sponsored ISPs (Clemente, 1998), with almost all of the remainder going to a commercial provider. In these years users contracted for commercial Internet access for one or more of several purposes:

! *Receive and participate in general communications functions using the Internet.* Users could accomplish this through either through email, proprietary and non-proprietary chat-rooms or through posting to bulletin boards, or participating in other virtual communal activities.

! *Gain access to goods and services with greater convenience.* Many users, either for private or business reasons, obtained Internet access as a means to take advantage of the virtual commercial activities organized by another business. These gains took several forms. Users in low-density areas and users with unusual buy/sell opportunities gained access to "thicker" markets, as Internet markets became central meeting areas for transactions. Users also could avoid some transaction costs through on-line transactions.

! *Take part in online entertainment or online content.* Many users took advantage of the widespread free content on the World Wide Web. This took a variety of forms, including games, trade journals, and news sites. A wide variety of these began to use advertising as a revenue source, some quite early.[4]

! *Reorganize and develop a sales or supply channel.* Many businesses established a virtual presence for both buying and selling. This allowed a business to alter its channel strategies. ISPs provided many business users with opportunities to coordinate their supply chains or their sales channels with an additional means of communication. While this is important, it is an activity which I will largely not observe in this paper.

As commercial ISPs quickly learned, the patterns of commercial Internet use displayed distinctly different characteristics than the academic use which dominated the Internet prior to commercialization. Three features especially influence pricing. First, most household users are not sophisticated and do not make use of complex or frontier Internet functions. Most surveys of

[4] Hotwired is regarded as the first site to use an Internet ad in 1994 (it was for Zima). DoubleClick began licensing its technology to web sites in September 1996. See Goldfarb [2000].

household use continue to show that the majority of household users devoted the majority of their time to the free services on the Internet (Goldfarb, 2000). Especially popular were well known functions such as e-mail, web portal use, news and entertainment, chat rooms and other community activity (Clemente, 1998). The proportion of such users grew as the Internet became adopted by more households. Hence, many ISPs were providing service to a relatively novice and unsophisticated user.

Second, the distribution of time the average user spent on the Internet was highly skewed, a trend that has continued to this day. Table 1 shows the distribution of time on line for a random sample of 2589 households for March, 2000, as recorded by Foveon Corporation, a marketing firm which anonymously tracks Internet use.[5] In this sample the median household spent a total of 10 hours on line during the month, with the upper quartile at approximately 30 hours. The skewness is quite pronounced: 10% of the users were over 60 hours a month on-line and 5% were over 90 hours.[6] Session length also displays skewness. The median session is approximately 10 minutes, with the upper quarter at approximately 30 minutes. 10% of the users have sessions over 75 minutes and 5% have sessions over 100 minutes.

Third, user demand tended to peak around certain times of the day and on certain days of the week.[7] During Monday through Thursday, when use is heaviest, demand tends to rise at

[5] These are all non-AOL users, though it bears strong resemblance to other surveys of AOL user behavior at non-AOL sites. This data has the advantage that users do not know they are being tracked (though it keeps to the FCC privacy guidelines). Most other surveys of on line use tend to under-represent activity which respondents do not want to discuss, such as surfing adult content. For further detail, see Goldfarb [2000] or www.Foveon.com.

[6] This is consistent with other surveys. See the Stanford Survey, 2000.

[7] The following is a crude summary of demand over the time of day, but enough for this paper's purposes, which is to discuss capacity use. Demand was measured by the time associated with new page refreshes. Peak demand is associated with the highest number of new pages. For example, for the Foveon sample, the highest

about 8 in the morning and remain at the same level until 3 PM, when it grows almost 25% and reaches a new peak level. Demand will tend to fluctuate around these high levels and possibly grow until 10PM. By 1AM it drops below it 8AM level. Friday through Sunday tend to have similar patterns over the day, but at substantially lower levels.

ISP needed to adjust their modem and backbone capacity to this portfolio of users and anticipated peak demands. To oversimplify, most ISPs handle two types of demand. One type, the majority of phone calls, are associated with short sessions by less-sophisticated users who put brief demands on the modems and backbone, especially in the afternoon and at night. Another type of use places a different type of demand on an ISPs's facilities. A small number of high volume and sophisticated users put sustained demand on facilities, accounting for a large fraction of the data flows and uninterrupted modem use at all times of the day. Both types of users could potentially make use of a wide array of functions or services other than just basic access, such as sophisticated servers for gaming, hosting, various web functions and other networking services. Key operational issues for many ISPs involved balancing their loads, not hurting performance and adjusting capacity to peak needs. These same issues influence pricing too.

C. Determinants of pricing

Most studies of pricing find considerable heterogeneity in the pricing behavior, partly as a reflection of real differences in economic conditions, such as market power or costs structure, and

demand was registered on Wednesday. There were 8,400 page calls between 8 and 9AM, 12,700 between 3 and 4 PM, 14,800 between 7 and 9 PM, 11,700 between 10 and 11 PM, and 8,500 between 11PM and 12 AM.

partly as 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 likely matter to a specific industry.

This study will examine a cross-section of price data from many different ISPs. I highlight seven determinants of price differences between firms.

! **Contracting practices:** ISPs could offer contracts which require different commitments from the user, either in terms of the number of months of service or in terms of limitations in the hours of use per month. Contracts could also bundle together different arrays of services, either in terms of basic functionality and in terms of optional advanced functionality. In practice, there are three categories of hypotheses to test:

1. Contract commitment by users. To save on customer acquisition/retention expenses, ISPs should find it profitable to discount their prices in exchange for longer user commitments, particularly for an experienced (and valuable) user who is at risk of leaving for another ISP. ISPs should also discount average monthly prices for new users who incur set-up fees.[8] This prediction is easily observable, but no theory predicts how large the discounts should be.

2. Limitations on use. By definition a high volume user on an unlimited contract receives a lower average price per hour than a low volume user (over the month), so ISPs should have incentives to discount their prices (relative to the monthly unlimited use) if users agree to limit

[8] Both instruments are similar to the user in that both might involve significant outlays at the outset and the maximum benefits are only realized by not moving away from the ISPs. However, set-up fees have the obvious draw-back that they may discourage "trial" use of service in the first place in comparison to a monthly contract without set up fees. In addition, some long term contracts do not require full payment at the outset.

their hourly service per month. These discounts could arise in either a very competitive setting or in a setting where an ISP has market power, a question discussed further below. Neither theory provides a prediction about how large these discounts should be. Hence, the first empirical task is to characterize how such discounting translates into average price per month over different volume of use.[9] The second task is to analyze why some ISPs use these types of contracts, while others do not.

3. Sorting users and maintaining a portfolio of prices. Some ISPs maintain a range of prices associated with different bundles of services. Others simply offer dial-up access and almost nothing else. Many potential motives lay behind an ISP's attempt to maintain a portfolio of prices and these motives should have consequences for observed prices. For example, if ISPs successfully sort users into different categories by volume of use, then it should have consequences for pricing of unlimited use. All other things equal, under most models of price discrimination, the unlimited access price will be lower if an ISP charges one price instead of charging an unlimited price and a limited one. It is impossible to observe "all other things equal" in practice, however, so this prediction can only be tested by comparing prices across two different ISPs, each of whom exhibits different pricing behavior.

! **Firm specific factors:** ISPs were established with different skills, experiences and

[9] Notice that this has some similarity to the usual story in cellular telephony where capacity is limited during peak times in dense urban market and firms charge the lowest average price per month to high volume user. However, there is one key difference. High volume use is finely metered in telephony, where a charge varies with volume and time of day. Hence, the private incentives to service high volume users of cellular telephony (relative to the incentives to serve low volume users) may be strong. With ISPs it may be privately profitable to pass on some savings to low volume users who do not use scarce capacity very often. In that case, it is possible that the comparative private incentives to serve many low volume users (instead of a high volume user) may be high, even though the average price per minute may be much lower for high volume users.

commercial focus. In the face of considerable ISP-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 services or between clusters of new services. In practice, this translates into three testable hypotheses:

4. Pricing for functionality. ISPs differ in their capital stocks, their investment behavior and in their marketing focus. These investments manifest themselves in better service, faster downloads, a wider array of services and so on. If users differ in their preferences for features linked to these decisions, then access prices may differ between the ISPs who differentiate with these features and those who do not. However, as is well known from the Rosen [1974] interpretation of hedonic regression in a cross-sectional setting, it is not possible to distinguish between explanations for hedonic coefficients which emphasize costs and those which emphasize demand. Nonetheless, even with that ambiguity, some predictions are weakly testable. Faster service should command higher prices. If the default contract gives the user access to more advanced services, then access prices should also be higher on average. Hence, there remains the interesting empirical question about whether any features, such as investment in fast connections or personalized service, command any private returns. If so, these can become important determinants of pricing differences.

5. Economies of scope at the ISP level. Many additional services are optional and priced

separate from access, but their mere presence at an ISP may be associated with lower/higher prices for access. An ISP may offer several services due to economies of scope in supply (e.g., it uses the same personnel) or complementarities in demand (e.g., if users prefer "one-stop shopping" for an array of Internet services). Since Greenstein [2000]showed that there was a higher propensity to offer these services in more competitive locations, economies of scope are observable in principle, but difficult to distinguish from other endogenous behavior.

6. Economies of scale at the ISP level. Many of the costs of operating a point of presence are independent of the scale of operation. The costs of expansion are small beyond certain sizes. If economies of scale are binding and if they influence costs, then they should also influence pricing. Smaller ISPs should have higher prices. However, this may be hard to observe because the larger national ISPs disproportionately locate in urban areas with higher densities, rendering economies of scale and density observably equivalent. One empirical challenge is to distinguish between the two.

! **Location and competitiveness:** 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. Virtually all urban areas are extremely competitive, while less dense rural areas contain few suppliers. This stark contrast underlies a series of related hypotheses:

7. Prices levels in urban settings. Urban markets have more firms. Also, economies of density lower delivery costs. Urban locations also tend to have more modern communications infrastructure. Hence, price levels should be lower in urban markets.

Larger market also size supports greater numbers of suppliers. Since national suppliers

disproportionately locate in urban areas, this factor should also lead to lower prices at national ISPs. However, if competitive pressures induce ISPs to sort between users, then more competitive settings in urban markets could yield more finely grained sorting of users, i.e., a wide variety of contracting practices.

3. Data

To characterize the offering of service in a quantitative way, some research assistants and I examined the price quotations of Internet Service Providers in the United States who advertise on *thelist*, a source for constructing a picture about a reasonably extensive sample of ISPs. This site, maintained by Meckler Media, provides the opportunity for both large and small ISPs to advertise their prices and services. ISPs fill out a questionnaire. Some answers are partially formatted, such as those involving speed, contact information and routine business hours. Some answers are not formatted, including those for prices and advanced services. The ISP is allowed to write whatever it wants to write within a display box. It does not seem to have much of a limitation on length. To the extent that ISPs successfully distill their services and prices into these displays, this allows users to compare different ISPs.

A. Constructing a sample

This data was collected over the course of about 6 months. The pricing quotations are taken from *thelist* in December, 1998, while the information on business lines comes from

September, 1998, using the product code in Greenstein [2000b]. The information about the location of ISPs comes from *thedirectory* in the summer of 1998, another data source described below and used extensively in Downes and Greenstein [1999].

The pricing quotations in this study are all dial-up prices mentioned by an ISP in *thelist*. This data is clearly superior to all potential alternatives, such as *Boardwatch*, which does not give as much information.[10] This data includes all relevant detail offered by the ISP about those prices, including set-up fees, discounts and other features. Still, this data is not a complete list of potential prices for all ISPs, nor can it possibly be a complete description of every feature of the contracts offered by ISPs. The propensity to describe a price can be both evidence of detail as well as evidence of the propensity of the ISP to provide user-friendly information (when the ISP had something to offer). Similarly, quoting multiple prices can be both evidence of the propensity to have multiple prices schedules as well as the propensity to market them to users in an attractive way. So this data must necessarily under-report on reality. As explained below, however, the observed behavior will be consistent with predicted economic conduct, so we will infer that these quotes reflect a real phenomenon.

The pricing data has never been used in any previous study, nor has any study used information about contracting practices, and only one paper has tried to relate pricing to the basic functionality offered by ISPs.[11] This data set does overlap with Greenstein [2000b], which examines the business lines of 3,816 ISPs in September 1998. There is also overlap with Downes

[10] An RA and I called thirty ISPs in the Chicago area and found that many offered a variety of pricing options which were not covered by *Boardwatch* but were covered by *thelist*.

[11] Citation to the price index for the Canadian ISPs.

and Greenstein [1999], which examines the geographic spread of ISPs, as well as with Greenstein [2000a], which examines a subset of these ISPs, the 2,089 small and medium sized ISPs for whom location is possible to identify both firm and location-specific determinants.

By construction every ISP 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. However, the data set 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).

For examining hypotheses 1-7, it was important to emphasize accuracy over increases in sample size. 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 ISPs. This paper will primarily examine 2486 ISPs who advertise on *thelist* in both September and December of 1998. This results in 4302 prices, counting set-up prices and monthly service prices within a single schedule. In the regression below I will only examine 3,166 total prices schedules for whom I have compete information about lines of business.

This study will also examine a subset of small and medium-sized ISPs for whom it was possible to characterize location. This sample is comprised of the ISPs examined in Greenstein [2000b].[12] This sample will only be used to examine hypothesis 7, where it is necessary to

[12] An ISP was included in the sample if the ISP listed the same domain name for the home page in both *thedirectory* and *thelist.* I first restricted the sample to 3,300 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

distinguish between ISPs in urban/rural locations. This involves 1,497 ISPs and 2,603 prices. Below 2,200 observations in the regression below will have complete records.

Concerns about over-sampling less complex price quotations seem unfounded. Those who do not quote any prices typically ask the reader to "call for further information." ISPs seem to do this for a variety of reasons, either because their normal contract is for a savvy business user or prices vary for a number of different bundles. Of the remainder, 1,460 ,or 58.7% of the ISPs, only quote one price schedule, typically (but not exclusively) a monthly unlimited price for household use. This seems to reflect the actual industry at this time: many small ISPs did have only one price and small ISPs make up the majority of the ISPs in the industry. In 377 cases, or 25.8% of the single price quotes, an ISP quotes only a single limited price, providing no information about their unlimited price, if one exists. In 14 cases a single business price is quoted. Still, 1,026 ISPs quote more than one price schedule for business and household use and often these quotes include enormous detail.[13]

The data on contract features is quite rich, but occasionally spotty. Most prices state the length of commitment required from a customer and other key conditions, if any apply. Generally it is in an ISP's interest to reveal information to potential customers, so many ISPs provide detailed information about their pricing schedules. In all but nine cases when an ISP discusses the

against approximately 5,400 ISPs in the Downes and Greenstein [1999] who were in five or fewer counties. *Thedirectory* places emphasis on listing the local dial-up phone numbers for many ISPs, which permits identification of the local points of presence for ISPs, and, hence, the local geographic territories served by any ISP who offers dial-up service. 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.

[13] 24.2% quote two price schedules, 9.9% quote three, 5.1% quote four and 2.0% quote five or more.

presence of a set-up fee, they announce its level. In contrast, while it is easy to get a sense of whether prices have some limitation attached to them, there is also often some imprecision about the terms of limitation. In 77% of the limited price schedules, the ISP quotes the precise limitation on the maximum hours in an unambiguous way; otherwise it is counted as missing.

Compared with pricing studies in other markets, this study has very good information about how the conditions of supply influence pricing, but only circumstantial evidence about how demand does so. Related, and similar to other studies, this data's greatest weakness is the absence of an non-coarse measure of quantity. There was no information source about measure market share between ISPs or between different contracts offered at the same ISP.

B. A first look at hypotheses 1 - 7

I first examine pricing using simple descriptive statistics and unconditional comparisons. This discussion highlights the extent of price variation in this market. It also will familiarize the reader with the wide variety of potential determinants of prices, which will play a role in the regressions below.

Table 2 displays a summary description of the variation in pricing. The first three columns of Table 2 includes prices for dial up access, normalized to their average monthly outlay, not including one-time set up fees. The rows express contracts of different length -- i.e., one month, three months, six months and a one year commitment. The columns express differences in hours limitations -- that is, whether the user agrees to limit monthly time to less than a set hourly maximum. It compares the average for prices with no hourly limitation with those with any such

limitation. The lower half also shows quotations for business use, as well as for dedicated use. Business bundles typically carry multiple email accounts, more storage for web pages and certain service guarantees. Dedicated use requires a dedicated phone line and modem, effectively guaranteeing the user access at any moment.[14] Table 2 also shows monthly price quotes for monthly prices with a setup fee (the set-up fee is not included in the price quote). Standard deviations are shown in parentheses. Sample size for the cell is written below.

Table 2 also shows that prices differ between the limited and unlimited contracts in household contracts, as expected. Monthly unlimited contracts for households are more than $4 higher on average than the average of the limited contracts. Less dramatic differences are present in the other contract categories, but the inference is weak due to small cell sample size. These results demonstrate the need to distinguish contract limitations of different severity.

! *Contract commitment and length:* Unsurprisingly, prices decline monotonically with length of contract. Monthly unlimited prices are $19.54/month on average if users sign up for a monthly contract, but $18.07/month if users sign up for a quarterly contract, $16.87/month for half year, and $15.15/month if users sign up for an annual contract. Prices are still quite dispersed in all cells, generally having standard deviations over three dollars. A similar monotonic discount arises in unlimited business prices, but smaller sample cell sizes results in a weaker inference. Average monthly unlimited prices are $30.03, quarterly are $28.70, half-yearly are $22.90 and

[14] Both business and dedicated prices are classified as such only when the ISP states this. By default, prices are household prices unless otherwise stated. We tested for a wide variety of different ways of quoting a different bundle. Most declarations were straightforward. We assume that these are dedicate plain old telephone service and not ISDN, since most ISPs state ISDN prices as something distinct and separate.

yearly are $21.51. The standard deviation is generally around $9 in this category, again leading to a weaker inference.

Table 2 contains a column with prices in which the ISP asks for a set up fee (approximately 18% of the price quotes). Setup fees average $20 (s.d. = $8.60) for the non-dedicated, household contracts. Table 2 illustrates one of the surprising findings in this data. There is no large difference between average monthly prices with set-up fees and monthly prices without, even controlling for contracts with longer commitments. This latter observation is not a strong finding due to small sample sizes, so it warrants further investigation.

A further look behind the table finds mixed evidence for hypothesis 1. One pattern fits the prediction. Set-up fees are more prevalent in shorter contracts and visa-versa, suggesting that ISPs trade-off between the two as instruments for inducing retention. 20.2% of the monthly price quotes list a set up fee, while only 11% of the quarterly, half-year and yearly price quotes list such a set-up fee. Similarly, 87.5% of the contracts with fees are monthly contracts, while a lower percentage of the contracts without fees, 77.82%, are monthly contracts.

Yet, monthly unlimited contracts with setup fees hardly differ from those without. Monthly unlimited household contracts have price levels of $18.18 (s.d. = $5.49), while the average with set up fees is higher at $18.66 (s.d. =$ 5.94). Among those contracts with set-up fees, the correlation between average monthly prices and the level of the set-up fees is positive -- i.e., 0.18 in all the data and 0.21 among monthly unlimited contracts. This runs counter to the prediction of hypothesis 1.

As I will discuss further below, this positive relationship between set-up fees and prices

suggests that a third factor, possibly unobserved quality of the ISP or market power, plays a role in the level of these fees. This pattern remains one of the open questions in this data.

! *Hour limitations:* Table 3 next looks at the hourly limitations in detail. There are 796 price quotes coming from 487 ISPs where the ISP provides information about the hour limitation above 5 hours a month. This is 18.5% of the price quotes in the data.[15] Fifteen of these are for business contracts and the remainder are for households. These limitations are remarkably dispersed. Out of the 781 household quotes, 27% are for 10 hours or less a month, 55% are for 30 hours or less a month, 69% are for 60 hours or less, 80% are for 100 hours or less. These numbers are quite skewed, similar to the surveys of Internet use at many households, as noted above. That said, most are low-volume limitations, limitations which would only make sense for occasional e-mail users, those with second accounts and recent adopters, in other words, the types of users who make up the vast majority of dial-up users in this time period.[16]

The correlation between these monthly prices and the numerical value of the hour limitation is 0.49, which is high and positive, as expected. This is consistent with hypothesis 2. In 497 cases the ISP provides both a limited monthly price *and* a monthly unlimited price (and sometimes more than one limited price). For this sub-sample the correlation between this *difference* and the numerical value of the hourly limitation is 0.26, which is weak support for hypothesis 2.

The highest hour limitation at an ISP (when it is known) follows a skewed pattern similar

[15] These data were constructed originally from the *thelist*, but were also supplemented with reference to the summer, 1998 issue of *Boardwatch magazine.* Less than 5% come from Boardwatch.

[16] Accordingly, might one also predict that these types of contracts to disappear as this market matures?

to that displayed in table 3. For 546 hour limitations (out of 806 total) the hour limitation is the "maximum" price charged by the ISP among the limited prices. In 260 cases it is not. 24% of the maximum hourly limitation involve limits on use of 100 hours or more, 15% are for 150 hours or more, 8% are for hourly limitations of 200 hours or more! Since so few users ever reach these levels of use a month, how can this make sense? Interviews with ISPs reveal that it is consistent with hypothesis 2 and 3, which presumes that high volume users are costly to serve because their high use is not metered. These high limitations come from ISPs who are trying to discourage the few users who want an ISP who is "always on," which is quite costly to deliver. Also, some ISPs want to give a few careless users an incentive to hang up.[17]

Further evidence for this explanation comes from a few cases where the ISP quotes an hourly price for service after the user exceeds the maximum. Generally these metered prices are quite high compared to the average price per hour below the limitations. 85% are higher than $0.50 an hour 0.40% are $1 or more.[18] For the few hundred cases with such prices, there was no relationship between the hourly price past the limit and average hourly price prior to the limit.[19] This is consistent with reports in the trade press that metered use largely disappeared due to its unpopularity with users (find cite) and has not been widely seen since the first few years of

[17] This is one feature which ISPs do not quote frequently on *thelist*, though it is my impression from interviews and the trade press that this type of limitations are more common in practice than found in this sample of quotes. Some so-called unlimited monthly contracts actually come with these limitations even though the ISP does not advertise it. Unfortunately, I was not able to locate any estimates of how common were these limitations with high levels.

[18] These are high in comparison. For example, a twenty hour limitation for $10 would be $0.50/hour at best. Indeed, most of these data result in average hourly rates much lower than the penalty price.

[19] This is one hypotheses which could use more data. However, most ISPs in this sample are small and most of these very high limitation are aimed at only a fraction of their users, so it is not a surprise that information about it is not widely advertised.

competition in the industry. Indeed, by 1998 the prices for additional hours were so high that they serve the purpose of encouraging users to stay below the time limitation.

! *Sorting and holding a portfolio of prices:* Table 4 illustrates preliminary evidence of hypothesis 3, that ISPs who sort differ from those who do not. This table shows the monthly unlimited prices for ISPs who quote multiple prices. Table 4 shows that the monthly unlimited household and business price for ISPs who quote one price, two price schedules, three schedules and more, where the additional schedules involve limitations on hours. 1,271 ISPs do not quote a limited monthly price at all. For this sample, the average unlimited monthly price is $19.03. For the 505 prices coming from ISPs who quote one additional limited price schedule the average of the monthly unlimited price is $19.71. It is $20.80 for the 214 from ISPs who quote two limited price schedules and $21.42 for the 161 with three or more. The correlation of the monthly unlimited household price and the maximum hourly limitation at an ISP (for 382 cases in which the limitation is known) is 0.32. Interestingly, the standard deviation of prices for monthly unlimited access also increases with the number of limited contracts. These patterns are suggestive of sorting and price discrimination. Admittingly, it is also quite coarse, since it does not control for other factors.

Interestingly, the pattern does not seem to be an artifact of the data: no such effect can be found in the monthly unlimited prices associated with multiple schedules with different lengths of commitment. This is shown in the row with monthly unlimited prices for those coming from ISPs who offer longer contracts. In that case, the average monthly price does not differ from the average from those with only one contract.

One interesting puzzle is the number of limited price quotes which come from ISPs with no unlimited access. 359 monthly price quotes come from ISPs who quote only one limited price -- by definition, no sorting is taking place. More surprising still, when the ISP quotes no unlimited price the average of quotes for monthly prices for limited access ($13.29, s.d. = $5.65) and the hour limitation (40.5, s.d. = 72.9) are relatively small. When an ISP quotes an unlimited price or more than one limited price, the average limited access price ($16.74, s.d. = $9.84) and average hourly limitations (59.7, s.d. = 78.9) are higher on average. Some of the higher price is due to the higher hourly limitation, but not all.

At the least, this is inconsistent with an explanation where low cost ISPs use the hour limitations for sorting purposes, but it is consistent with an explanation where high cost firms do. However it is unclear why high cost firms would do so more than low cost firms. It also could be consistent with an explanation where firms with market power charge high unlimited prices and also use these contracts with more frequency.

! *Miscellaneous features of the contract:* Table 2 shows information about access for business; making up close to 10% of all quotes and containing a wide variety of contracting conditions. As noted, business bundles typically carry multiple email accounts, more storage for web pages and certain service guarantees. The table illustrates that this bundle of services commands a premium over household contracts. Business and personal contracts differ sharply in price levels. On average, business contracts are almost $10 higher, though there is a striking decline with length of commitment in the few cases where longer contracts are offered.

Related, dedicated access, for which we found just over 111 price quotes, also commands

a high premium (and wide variance) over monthly unlimited contracts. As noted, dedicated use effectively guarantees the user, typically a business, access at any moment. Due to the infrequency of price quotes for dedicated service, this does not seem to be an inexpensive service for an ISP to provide, nor a particularly common type of access for a business to demand. This is not surprising. After all, if a business had sufficient demand to merit a dedicated phone line for Internet access, then that same business might also have sufficient demand to merit something else, such as ISDN service or direct access. Also, if an ISP was sophisticated enough to know how to offer dedicated service, it probably also contained the engineering talent to do these other things.

One other idiosyncratic feature of the data deserves note. In 94.5% prices the record states the date at which it filled in the survey at *thelist.* By definition this date tells us about the most recent date at which the ISP filled out the survey on *thelist*.[20] *Thelist* first began including a field for recording such a date twenty months prior to our sampling. Average monthly unlimited prices for the most recent ten months of entries was $18.89 (s.d. = $3.53), while it is $19.99 (s.d. = $4.00) for the previous ten months. If the month is a number between 1 and 20, where the highest number indicates that the price quote is recent and the lowest number indicates that it came from twenty months ago, then the correlation between this number and the monthly unlimited price is -0.15. In other words, there is a slight tendency for more recent price quotes to be lower.

[20] As it turned out, this variable reduced the sample size more than any other. For unknown reason, many prices did not have a date on it. We simply dropped these observations.

Certainly the decline in price quotes is evidence that nominal prices were generally declining over the previous twenty months. However, this information is not a price index in the usual sense, since filling out the survey may not be a random sample of the population of ISPs and newer/older prices may not be a random sample of prices from present/previous periods. An interesting open question is whether there is a relationship between this type of survey instrument and a true price index.

! *Features of the ISP:* There is mixed and relatively coarse evidence that prices are sensitive to the quality of the ISP. In 84 cases, the monthly unlimited prices come from ISPs who also quote prices for dedicated access, a service requiring some advanced engineering skills. These 84 prices average $20.81 (s.d. = $6.06), higher than $19.49 (s.d. = $3.78) for the other prices. In 745 cases the ISP also quote or mention prices for direct access, again a measure of the engineering skill of the ISP personnel. In this case, however, the prices do not differ. 217 prices come from ISPs who did not check the box on *thelist* for "T-1", signaling potentially slower backbone connections. These prices are $19.03 (s.d. = $4.17), lower than average for those who do check this box, where the prices are $19.84 (s.d. = $3.89). These are not strong findings, but they point toward examining the quality of the ISP, if possible.

! *Economies of Scope:* Table 4 has a coarse test of economies of scope, hypothesis 5. It shows the prices for monthly unlimited access at ISPs who offer different type of optional service, such as hosting, networking, web design and frontier access, as measured in Greenstein [2000]. ISPs who offer hosting services tend to have prices at $19.47. Those offering web design services have prices at $19.77 and networking at $19.58. These do not differ much from each other, nor

from an unlimited price, which suggests that there is little or no premium for dial-up access prices coming from an ISP who also offers secondary services.

! *Economies of scale:* Price levels decline in ISP size, as hypotheses 6 predicts. There are 830 ISPs in only one area code who have a monthly unlimited price. This is $20.08 on average (s.d. = $4.13). The 657 with service in 2 to 5 area codes have prices averaging $19.63 (s.d. = $3.76). The 233 with service in more than 5 area codes have prices averaging $18.79 (s.d. = $3.52). This is consistent with the presence of economies of scale. However, these economies seem to be exhausted at relatively low levels of geographic availability, which is partly not surprising since it is actually quite easy to offer wide geographic coverage using other firm's facilities. Prices levels did not differ much at ISPs offering service in more than area codes than six area codes.

! *Location and pricing:* How do price levels vary with density of location? As one coarse test, I examine the 1292 personal monthly unlimited price quotes coming from small and medium ISPs located in urban and rural areas. Almost 95% of these ISPs are "local" in the sense used in Downes and Greenstein [1999], offering dial-up point of presence in three or fewer counties. 965 price quotes come from urban areas, i.e., the US Census designates the county as an MSA. 223 ISPs come from rural areas and 104 involve a mix. The urban price levels average $19.35 (s.d. = $3.67), the mixed average $20.87 (s.d. = $4.68) and the rural prices average $21.16 (s.d. = $4.17), which are large differences. In other words, prices decrease with density and competitive setting, as forecast by Hypothesis 7. This is consistent with the presence of economies of density in urban areas and the importance of more competitors in urban areas.

4. A hedonic approach to measuring the determinants of ISP pricing

The remainder of the paper develops hypotheses 1-7 in a regression setting, where it is possible to control for multiple factors. The study shows three types of tests. First, it examines how contracting practices influence prices, and how features of the ISPs influence prices, testing hypotheses 1-6. Second, it examines the same factors but controls for location, giving special emphasis to hypothesis 7. In both cases it will find that contracting practices are the major determinant of measurable pricing. These findings will then beg the question about why ISPs use different contracting practices. That is the third type of test, and it comes at the end of the discussion.

There are two strengths to using regressions to test the hypotheses. First, a regression can measure the influence of variables across all the prices simultaneously, both limited and unlimited as well as longer and shorter commitment. Hence, we can understand the influence of many factors over a range of prices. Second, a regression can control for multiple factors which tend to be weakly correlated, such as economies of density and scale. Thus, we can characterize the entire data set at once and reduce some of the ambiguities which arose in the unconditional examination.

Some of the findings noted above will continue to arise in this setting. There will be strong support for the importance of discounting and contract length but weaker evidence of sorting behavior. There will be some evidence that the quality of the ISP influences prices, but little evidence that the presence of economies of scope influences prices. Economies of scale will be much weaker than the unconditional tests above indicated. Location will continue to be important

to prices, but less so than in the unconditional tests above. Most of the evidence about sorting will continue to point toward cost-driven explanations and a little will point toward the presence of market power.

A. Measuring contracting practices and features of the ISP

Table 5 lists the descriptive statistics for the main variables. Table 6 is organized around hypotheses 1-7. These are comprised of all business and household price quotes for which there were no missing variables on essential features of the price schedule and features describing the ISP. There were 3,166 such price quotes.[21] Of these, 2,200 come from small and medium ISPs whose location is known. The exogenous variables are similar to those discussed above. A few more are added to account for additional factors. These variables are specified as follows:

! *Length of Contract:* **Quarterly, half-annually** and **yearly** are dummy variables representing contracts that required 3, 6 or 12 month commitments. **Monthly** is omitted. **Set-up** is a dummy representing whether the price schedule included a setup fee.

! *Limited contracts:* **Limited** is a dummy that takes a value of one if price is limited. **Onlyonelimited** takes a value of one if this limited price is the only price quote from the IPS; it is zero otherwise. **Lim10-Lim60** are dummies measuring the range of the hourly limitation per month. For example, **Lim10** is one if the hourly limitation is for 10 hours or less per month, **Lim20** is one if it is for 20 hours or less per month, and so on. The omitted variable are all

[21] Obtaining information about the functions of the ISP was the largest constraint on the sample size.

contracts with limitations over 60.[22]

! *Portfolio effects and sorting:* The omitted contract in the regression is a monthly unlimited contract from an ISP that only quotes a single price for unlimited monthly service and nothing else. Accordingly, **Notsingular** is zero if an unlimited contract is the only price quote from the ISP. It is one otherwise. **Limitedeffect** is a dummy that takes a value of one if an unlimited contract comes from an ISP who also quotes prices with hourly limitations. **Numbereffect** measures how the number of prices with limitations influence unlimited contracts. **Maximumeffect** measures the influence of the maximum hourly limit on unlimited contracts. **Billingeffect** is a dummy for how offering contracts of different length influence unlimited prices. It is one if the ISP offers any contract of length beyond a month.

! *Miscellaneous*: **Business** is a dummy for whether the contract is a business quote or not.[23] **Dateindicator** is a number between 1 and 20, where the highest number indicates that the price quote is recent, as noted earlier. This corrects for biases associated with the survey date. It is not a price index in the usual sense.

! *Features of the ISPs:* Most of these try to measure the quality of service at an ISP. **Offersdedicated** is a dummy for whether the ISP quoted a price for dedicated service. **Frontier** is a dummy for whether the ISP advertised direct access. **T-1backbone** is a dummy for whether ISP checked the box on the *thelist* that it had a T-1 line.[24] **ISDN** is a dummy for whether the ISP

[22] Experiments with dummy variables at these levels did not find significance.

[23] The results are unchanged whether these observations are included or excluded. So these were included just to show the premium associated with the business bundle.

[24] Note: **Frontier** in Greenstein [2000] differed from **Frontier** in this study. In the previous study **Frontier** was defined analogously to **T-1backbone** in this paper.

advertises ISDN service. The next two dummies measure whether the ISP is trying to be friendly toward unsophisticated users by talking about things which all ISPs do as a matter of routine. **Complements** and **Oldtechnology** measure whether the ISP advertisement discusses complementary technology and old access technology.[25] The next five dummies measure features of the ISP which the ISP highlighted in their ad. **Real** is a dummy for whether the ISP claims to support streaming, which at the time primarily came from Real Audio.[26] **Games, Chat, Video** and **Screening** are dummies for whether the ISP supports games, chat rooms, video conferencing and screening services (e.g., Cyber Nanny), all of which require additional equipment and service from the ISP.

! *Economies of Scope*: These two dummies indicate whether the ISP discusses any additional services in one of two places, where such services are either networking, hosting or web design, as discussed above. If the ISP discusses these services along with its price quotations, then **scope1** equals one, zero otherwise**.** If it discusses such services along with its advertisements about new services, then **scope2** equals one, zero otherwise**.**[27]

! *Economies of Scale:* This is two dummies. **Area1** is one if the ISP covers only one area code. **Area2-5** is a dummy if the ISP covers 2-5 area codes. The omitted variable is 6 or more.

! *Location*: **Frprof** is an estimate of the fraction of the working population in these

[25] These formed the basis for **handholding** in Greenstein [2000], which also looked an ISP's propensity to advertise capabilities toward unsophisticated users.

[26] This is a mildly deceptive statement. By the end of 1998, there were a number of substitute streaming products and services entering the market and many ISPs could handle those. However, because observations about ISP capability come from the summer and winter of 1998, as well as previous months, a disproportionate number of ISPs discuss their ability to carry Real's products, even when they could do other things.

[27] A number of other combinations of ISP services were tried, but all came up insignificant, as will these dummies. This is the simplest measurement, so this is what is shown.

counties who work in white collar work.[28] **Rural** is a dummy which is one if the ISP occupies a county which is not designated as part of a major MSA, as recorded by the Census. **Urban/rural** is a dummy that is one if the ISP serves an area which mixes MSA counties and non-MSA counties. The omitted variable is **Urban**, which is the majority of the price quotes.

B. Descriptive Results

Regression results are in Table 6, where price is the unit of observation. The first two columns use the log of prices as the endogenous variable.[29] The second two columns use price levels as the endogenous variables. The second and fourth columns use all 3166 observations for which we have complete records about contracting and lines of business. The first, third and fifth columns report results for 2200 observations for which we also have geographic information. In four OLS estimates, the standard errors are robust standard errors using the standard White correction for heteroscedasticity. The last column includes a median regression on price levels for comparative purposes.

A price is the unit of observation. In all cases there has been no correction of the error for multiple observations from the same ISP, which, arguably, might improve the standard errors. In addition, the estimates have not been weighted for the size of the ISPs nor any coarse measure of market share, such as the number of area codes.

[28] As with scope, the paper shows the most parsimonious specification. Many other specifications were tried and failed to yield interesting results. These other variables included many of the variables found in Augereau and Greenstein [2000], such as population ages, education ranges, presence of universities nearby, RBOC presence and fraction of population using PC at home or work.

[29] At this time we found only one example of a "free" ISP. This observation was omitted.

! *Length of Contract:* **Quarterly, half-annually** and **yearly** have their anticipated benefit compared with monthly contracts. The point estimates are all in the same range. There is at least a 6% discount for a quarterly contract, a 15% discount for a six month contract and a 23% discount for a yearly contract. These translate into savings of at least $1.20, $3.30 and $4.30. These are large and important.

Set-up is a weak positive predictor of monthly prices. Generally, prices increases by 4% when there is a setup fee or about $0.64 on average. The median regression also finds a positive effect, but a relatively small one. In spite of attempts to control for unobserved quality, this variable may be mixing commitment effects with payment for unobserved quality of the ISP or the bundle of services or market power.

! *Limited contracts:* **Limited** is insignificant, indicating that, controlling for other factors, prices with hourly limitations above 60 hours do not differ from those without limitations. However, if an ISP offers only a single limited price, as indicated by **Onlyonelimited**, it tends to be lower than similar contracts from other ISPs who have a range. The estimates provide unreliable evidence on the extent of this effect. The lowest estimate is 7.3 % discount, but in levels the estimates range from $0.15 in the median regression to almost a $2.00 discount in the OLS regressions in levels. This could be a symptom of an sorting or it could be an artifact of the data source – i.e, if an ISP quotes only one limited price, it tends to quote its best price, while ISPs who quote all their prices show a wider range.

Lim10-Lim60 demonstrate the range of discounts associated with hourly limitations. The

first big discount arises in contracts with monthly hourly limitations under 60.[30] The lowest estimate is 30% and the point estimates in levels exceed $4.20, which is substantial. The next biggest jump in discounts came at the 30 hour range. Here the discounts are an *additional* amount, estimated in excess of 21% in their lowest estimate or almost $2. Contract limitations under ten hours a month also result in big discounts, at least 14.5%. The estimates of levels are slightly harder to interpret, since a ten hour contract combines both a $1.26 and $1.53 additional discount over other discounts. The median regression puts that statistically significant level of discount at 20 hours, estimating an additional discount of $2.93. In other words, all estimates point toward the presence of important thresholds at 60 hours, 30 hours and one more level lower, somewhere between 10 and 20 hours. Each threshold is worth an additional $2-$4 discount.

The results are mildly deceptive if not interpreted carefully. It is rare for a limited price to involve a contract beyond a month and, visa versa, it is very rare for a lengthy contract to involve an hour limitation. As Table 2 showed, many ISPs place limitations on a monthly contract and/or offer longer commitments, but only a few quote both for the same contract. For example, 15.3% of the monthly contracts have a limitation of 60 hours or less. 12.1% of monthly contracts have a limitation of 30 hours or less. Yet, only 3.6% of the longer contracts are for under 60 hours and only 2.4% are under 30 hours. In other words, many ISPs use a variety of methods to quote a price which effectively discounts against the overall average monthly unlimited price. This discount easily falls in the range of 25% to 50%, but rarely more than that. The largest measured

[30] Experiments with dummies at these levels did not find significance in any dummies.

discounts due to hourly limitations disproportionately show up on monthly contracts, if at all, and rarely on longer contracts.

! *Portfolio effects and sorting:* The omitted contract in the regression is deliberately set to a monthly unlimited contract from an ISP who only quotes a single price for unlimited monthly service and nothing else. **Notsingular** is positive and borderline significant with relatively low estimates (3% discount or $0.50 discount), providing weak evidence that singularity alone matters for pricing. In addition, **Billingeffect, Limitedeffect, Numbereffect** all do not matter. This indicates that contracts of different length do not influence unlimited prices; nor does offering a limited contract by itself; nor does offering more of them.

However, **Maximumeffect** is significant in all estimates. It shows that the maximum hourly limitation on a limited contract does influence unlimited contracts.[31] The coefficient appears small in all cases, but this is deceptive without further interpretation. Conditional on **Maximumeffect** being positive, the median for **Maximumeffect** is 30 and the average (and upper quartile) for **Maximumeffect** is 76 (s.d. = 90). In other words, the influence of this limitation on unlimited prices is large for the upper quartile of observations, for over 100 observations have both limited contracts in this range and unlimited contracts. If the maximum hourly limited contract is 75 than the unlimited price is 6% or $1.30 higher.[32] For 150 unlimited contract the premium is 12% or $2.30 high. This pattern appears consistent with sorting behavior. However,

[31] There is an interesting correlation between Maximumeffect and NumberEffect. When Maximumeffect is removed from the specification, then number effect becomes significant. In other words, the largest hourly maximum also tend to arise at ISPs who quote the most limited prices.

[32] The coefficients in columns 1 and 3 are .000798 and .0172.

as noted earlier, the majority of the sample involves observations with maximum hourly limitations which are not as large as this. So in the majority of ISPs limitations push unlimited prices up less than a dollar.

! *Miscellaneous*: **Business** contracts command a high premium, though there is a range to these estimates. Controlling for other factors, these contracts tend to be at least 38% higher or $10.00 in the smallest estimates, consistent with the inferences above.

Dateindicator also is important. The difference over twenty months amounts to a 5.6% decrease in prices or approximately $1 in the estimates on levels.[33] This translates into approximately $0.60 a year, which is quantitatively important. It is an open question whether this is an overestimate or an underestimate of the true decline in prices over the period, but it certainly suggests the degree of change in the young market.

! *Features of the ISPs:* Two factors measuring the engineering quality of the ISP are significant and large in every estimate. These are **Offersdedicated** and **Frontier,** respectively whether the ISP quoted a price for dedicated service and whether the ISP advertised direct access. The latter is much more common than the former, but ISPs likely to do one are slightly more likely to do both. The estimated premia range from small to large. The smallest are a 3.5% and 2.8% effect on prices, or a $0.75 and $0.59 effects on levels. The other measures of engineering capability, **T-1backbone** and **ISDN** give inconsistent or weak results.

Most other features of ISP do not influence prices. **Complements** and **Oldtechnology** give inconsistent and weak estimates. **Real, Chat, Video** and **Screening** do not influence prices.

[33] The coefficients are -.0028 and -.052.

Only **Games** appears to influence dial-up prices. At its lowest, it commands a 5.5% premium or $0.80, with some estimates being much stronger. This is interesting since it measures a different capability and customer focus than either **Offersdedicated** or **Frontier**. On the other hand, it is puzzling. If the additional work associated with games commands some returns, why don't any of these other services? And why is it so uncommon (4% of prices)?

! *Economies of Scope*: There was no evidence of economies of scope. The estimates reports the simplest of many potential specifications, none of which found any positive evidence. Certainly many ISPs believe that there are economies of scope, both on the supply side and on the demand side. So this non-result is either evidence that there are no economies of scope present in dial-up pricing or that it is improperly measured.

! *Economies of Scale:* The evidence for economies of scale is weak, at best. Both **Area1** and **Area2-5** are small and mostly insignificant. This contrasts with the strong economies of scale in the unconditional data, suggesting that ISP size correlates with many other contracting practices which reduce prices.

! *Location*: **Frprof** does not influence prices, nor do other factors associated with a local area. However, controlling for other factors, **Rural** prices and mixed rural prices are higher than urban prices. However, the coefficients take on a large range, providing mixed evidence of the influence of economies of density and competition. This contrasts sharply with the examination of prices, not conditioning for other factors. As with ISP size, it too suggests that an ISP's location correlates with many other factors which reduce prices.

C. Interpreting the results: As noted at the outset, the spirit of this study is to explain the dispersion of prices with information about the features of the contracts, the ISPs offering the service and its location. The study appears to have met this goal. The fraction of variance explained by these simple regressions exceed 42%. This is remarkably successful for a cross-sectional regression. Indeed, the most important determinants of prices are contract length, hour limitation, business/household differences and the date of record, in other words, mostly contracting practices. A regression on contracting practices alone almost explains as large fraction of variance.[34]

In addition to the finding about contracting, the regression identified other important patterns. For some observations an important factor is whether the ISP offers frontier services or games. There is some evidence that ISPs are sorting users or altering the portfolio of prices. There is evidence that the density of the location of the ISP influences overall price levels, but this is weaker than trends with unconditional data. There is no evidence of economies of scale once one controls for other factors, contrasting with the strong trend in unconditional data. There is also no evidence of economies of scope between access prices and related Internet services. In addition, many functions featured prominently in ISP marketing do not explain differences in prices. This includes factors such as an ISP's friendliness, and its ability to support streaming, chat services or screening.

Overall, it is possible to explain a large fraction of discounting using observable features of

[34] This is not shown, but the results are available from the author upon request. This should not be surprising since only a few of the features of ISPs, economies of scope, scale and location explain much.

contracts and portfolio effects. 24% of the prices in the sample have an hourly limitation on use. 13% of the sample (more than half the limited prices) have hourly limitations at 60 hours or less, where the discounting has significant quantitative influence. 37% of the limited prices (or about 9% of all price quotes) are not part of a portfolio of limited prices, a factor that leads to lower price quotes. Of those with large hourly limitations, the magnitude of the limitation also influences the unlimited price, a factor of relevance to about 3% of the prices. A large number of prices are sensitive to the estimates for contract length: 12% of the price quotes require yearly commitments and 10% of require three or six month commitments.

It is also possible to explain some fraction of higher prices due to ISP quality and location. 7% of the price quotes are business prices, a factor which increases prices substantially. In addition, 5% of the price quotes come from ISPs who offer dedicated access and 36% come from ISPs who offer some sort of direct access, factors which both command a premium. About 25% of the price quotes come from ISPs in low density areas, another factor leading to higher prices.

These results beg a related line of questioning: why do some ISPs offer multiple price schedules and others do not? Why do some ISPs offer contracts of different length and others do not? And why do some offer limited contracts and others do not? That is, contracting practices are endogenous at some level. Up until now, these have been treated as exogenous.

To examine these questions I examine differences in contracting practices across ISPs in different locations. If the propensity to use contracting practices arises from the ability of an ISP to use market power, then the practice ought to rise in rural settings and decline with the national ISPs who locate in urban settings. It ought to also rise in rural settings with fewer competitors.

The opposite should hold if competitive pressures induce the use of contracting practices. To be sure, the comparison is not exact, since rural settings are also more costly to serve and demand is generally thinner in the same places where fewer competitors enter. Also, larger ISPs became large by offering high quality service, a factor that potentially translates into higher prices associated with branding or faster service. Even with these qualifications, however, this approach will shed light on these questions.

First, I examine the number of limited contracts. Limited contracts seem to be a function of size, which partly suggests that market power is a determinant. 33.0% of the ISPs operating in one area code offer such limited contracts, while 32.6% ISPs in 2-5 area codes do so and 26.3% of the ISPs in 6 or more area codes do so.[35] The pattern is as striking for the quotes where the hourly limitation is known. The comparable numbers are 24.0%, 18.2% and 16.3%.[36] In other words, the propensity to offer limited contracts declines as ISPs get larger (and more national in scope). Of course, this could also be evidence that this pricing behavior may have a capacity-based determinant, though it is unclear how this explanation would work precisely.[37]

Next, it is also possible to examine how the propensity to offer limited contracts varies between urban and rural markets. These results are mixed. The propensity to advertise more than one limited contract does not differ in rural and urban areas, conditional on advertising any limited contracts. Hence, the key issue is how often limited contracts are quoted at all, not whether they

[35] This was 317 out of 962 ISPs, 251 out of 770 ISPs, and 71 out of 270 ISPs. A total of 2,002 ISPs in this sample gave precise information about area codes.

[36] These are 231, 140 and 44, respectively.

[37] Why would capacity-constrained firms disproportionately advertise prices with hour limitations? Wouldn't they be vulnerable to the entry of other firms advertising unlimited prices? Hence, this explanation seems to make sense only in the presence of market power.

are quoted as part of a portfolio. Among the sample for which geographic data is available, 31.4% of small ISPs in rural areas offer such contracts, while 34.5% of those in partial rural areas do so and 32.8% of those in urban areas do so.[38] When the hourly limitations are available the numbers are 30.6%, 32.7% and 18.0%. The last percentage means one of two things. First, it could mean that ISPs in the more competitive urban settings are *less* likely to offer these discounts, which is consistent with the importance of market power. Second, it could mean that ISPs in urban settings are just disproportionately less likely to advertise their hourly limitations, which has no obvious economic determinant.

Next I examine how the propensity to offer limited contracts varies over ISPs who are solely in rural settings. These ISPs are generally in towns and cities which are isolated from urban areas, serving smaller communities and low density areas. The patterns are quite striking. Of the 120 prices coming from ISPs in rural areas where Downes and Greenstein [1999][39] find two or fewer local or regional competitors, 43% have some sort of hour limitation. Of the 164 prices coming from ISPs with between 3 and 5 competitors, the percentage of limited contracts is 31.7%. Of the 178 prices coming from ISPs who face 6 or more competitors, the percentage of limited contracts is 25.2%.[40] To be sure, this is consistent with both the presence of market power

[38] This was 80 out of 255, 39 out of 113 and 32.8 out of 1,129. Location information was available for a total of 1,497 small and medium ISPs.

[39] Downes and Greenstein count the number of commercial ISPs who advertise in September 1998, then assign them to counties based on their phone numbers and city affiliations, as noted on thedirectory. Generally, there are few national competitors in areas with fewer than 6 local or regional competitors. Hence, the divisions above represent "little local competition", "some local competition" and "competition from local and national ISPs." Note that these are all low density areas, but, generally speaking, these labels correlate highly with different density levels.

[40] It generally stays at that level no matter how many competitors one examines above six. Six was the lowest number at which the percentage reached approximately 25%.

and higher costs due to lower densities. Monthly unlimited prices are $22.00 (s.d. = $5.27, N = 53), $21.48 (s.d. = 4.07, N= 85) and $20.31 (s.d. = $3.30, N= 85), respectively.[41]

Next I examine the length of contract. These do not vary systematically among ISPs of different size. Those in one area code offer longer contracts 20.6% of the time. For those in 2-5 area codes the propensity is 23.8% and for those in more than 5 the propensity is 19.3%. However, these do differ among ISPs in different locations. 17.9% of the ISPs in rural areas require contract commitments exceeding a month, 20.2% of those in urban/rural mixes require commitments exceeding a month, and 23.3% of those in urban areas do. These are not very big differences, but it does suggest that the propensity increases with competitive pressure. Consistent with this pattern, the use of longer contracts also seems to be mildly influenced by the number of competitors in rural areas. Using the same three rural segments as above, the prices with longer contracts are 13.3%, 10.6% and 19.2% of the total, as one moves from fewer to more competitors. Again, it appears the longer contracts arise a bit more frequently in more competitive settings.

The other important determinants of prices largely do not differ between urban/rural areas. Business contracts arise at a mildly lower propensity in rural areas, but it is not a large difference, nor does it appear to be a function of competitors. The propensity to charge a setup fee also do not differ between urban and rural areas, though it is extremely common among the prices coming

[41] It is simpler to show these tabulations. Surprisingly, controlling for other factors, I was unable to find any relationship between the number of competitors in rural areas and price levels. In other words, contracting practices continued to explain the level of prices generally and estimate zero coefficients on the number of competitors.

from ISPs in counties with 2 or fewer ISP.[42] There is no difference between business and setup in geographically small and large ISPs. The propensity to offer dedicated access or games also does not differ much in either case, though the propensity to offer dedicated access does decline mildly among national ISPs.[43]

The propensity to advertise frontier services, however, is lower in the rural areas. 38% of the prices from ISPs in urban areas come from ISPs advertising frontier access, while the percentages are 32% for ISP in mixed urban/rural areas and 14% for those in rural areas.[44] It is also lower among the smaller ISPs. 25% of the prices coming from ISP in one area code advertise frontier services, while the propensities are 43% and 49% for ISPs in, respectively, 2-5 area codes and 6 area codes. This is consistent with the findings of Greenstein [2000], that urban ISPs and national ISPs have more advanced services; in this setting, it is responsible for a mild overall difference in prices, estimated between $0.59 and $0.80.

Overall, smaller ISPs, ISPs in rural areas and ISPs with fewer competitors are more likely to quote limited contracts. ISPs in urban areas and more competitive rural areas are also more likely to quote contracts over a month. This is interesting since ISPs tend do one or the other but not both inside a single contract. In one type of location users get discounts through longer contracts, in the other through volume limitations. Thus, the propensity to use different contracting practices does not largely account for the difference in prices between urban and rural

[42] One third of the prices coming from ISPs in counties with two or fewer competitors have a set-up fee, while the percentage for all rural firms is roughly half that at 17%.

[43] It is 5.1% in prices quoted from ISPs in one area code, 4.8 in prices quoted from ISPs in 2-5 area codes and 2.2 in prices quoted from ISPs in over 6.

[44] Consistent with this, this percentage is mildly higher among the firms with more competitors, which is probably a function of density.

areas.

Interestingly, the price difference between urban/rural areas is partly a function of the quality of the ISP. This translates directly into a price premium for high quality service. Even then, this only explain no more than half (i.e., less than one dollar) of the urban/rural difference in prices.

It is much easier to see the competitive forces at work in this data than market power, though the latter certainly cannot be ruled out. There is plenty of evidence of price discrimination -- i.e., in discounts for longer commitments, in sorting users between different limitations, and in the influence of limited prices on unlimited prices. Some of it arises from market power and some from competitive forces. However, there are plenty of other important pricing behavior with a simple competitive interpretation -- i.e., business bundles, setup fees, and the returns to ISPs with engineering capabilities. Each of these has a ready cost-based explanation and interpretation. Finally, half of the urban/rural differences in prices appears to be a function of the quality of the ISP. The remainder appears to be one of two things: either (1) economies of density raising costs in low density areas when demand is low or (2) market power at rural ISPs. Even so, since rural ISPs are a small percent of the market, at most it accounts for a small fraction of pricing.

5. Conclusion

As one of the first mass markets for data communication service, the Internet access business frames a number of interesting puzzles and open questions. What principles for price

measurement are appropriate here? First, there is good news. It is possible to explain a large fraction of variance in prices with a small number of readily observable features of contracts and ISPs. This means that, with the addition of information on market share, a broad index should not be difficult to construct for many of the most common contracts. Second, and related, some sampling is not difficult in principle, since many ISPs offer roughly similar services in similar packages. With the construction of a product classification code for these services, these findings support the use of standard practices for price index construction.

Not all the news is positive, however. First, there appears to be important qualitative difference across ISPs, a finding that suggests the need to control for qualitative dimensions of service such as speed and the area of service. These differences are likely to go unmeasured otherwise. Second, there appear to be important differences in the bundles of services offered, again suggesting the need to control for qualitative features such as the number of email accounts in a business contract. Third, and related to both points, there is no reason to think that these unmeasured qualities change over time at the same rate, particularly if these relate to different market structures at the local level. These changes are especially likely to be unmeasured because of flat-rate pricing, where use of standardized services goes unmetered. This leads to potential bias in standard price indices.

How does this study compare with other familiar communications markets? There are many intriguing similarities and differences. There is one obvious similarity: High volume users still pay less per hour than low volume users. However, some vendors use a variety of contracting practices to sort users into different volumes of use. Hour limitations work on different principles

here, since high volume use is not finely metered.

Related, though it is not easy to monitor data-flows for each user during different times of the day, three pricing patterns suggest nuances to the usual story. First, some ISPs do price with limitation over the course of the month. This seems directed at a small minority of users with particularly high volumes of use. Second, the prevalent use of hour limitations in less competitive situations (instead of long term discounts) suggests that users and vendors may view this contracting feature differently. These findings are consistent with a market in which users have a distaste for such limitations and competitive pressures prevent ISPs from using them often. Third, there is some evidence that there are private returns to high quality facilities, suggesting some users want to pay extra for performance and some do not. These three findings together are interesting because economists typically discuss the efficiency gains from the adoption of fine metering, particularly for high volume users, but not the disutility of metering for some users. Nor is there much discussion about heterogeniety in user valuation of the cost/benefits of high speed performance. This behavior poses some interesting theoretical issues regarding the optimal menu of contract limitations and whether private markets achieve second best solutions.

ISPs are the commercial gateway to a large fraction of the activity associated with the web. Judging from the variety of pricing schemes, many facets of Internet access pricing fall within the scope of competitive behavior found in many other industries. Overall market prices are constrained by private costs, by competitive pressures and by the cleverness of ISPs to come up with new pricing plans. It open question how these pricing schemes will evolve as so-called "free" ISPs diffuse and as broadband data communications becomes a mass market service.

Table 1

Monthly use in terms of minutes

Range	Raw number	Percent	Cumulative
0 to 299	545	0.211	0.211
300 to 499	367	0.142	0.352
500 to 699	264	0.102	0.454
700 to 899	192	0.074	0.528
900 to 1099	166	0.064	0.593
1100 to 1299	126	0.049	0.641
1300 to 1499	89	0.034	0.676
1500 to 1699	99	0.038	0.714
1700 to 1899	76	0.029	0.743
1900 to 2099	62	0.024	0.767
2100 to 2299	49	0.019	0.786
2300 to 2499	56	0.022	0.808
2500 to 2699	46	0.018	0.825
2700 to 2899	43	0.017	0.842
2900 to 3099	35	0.014	0.856
3100 to 3299	28	0.011	0.866
3300 to 3499	37	0.014	0.881
3500 to 3699	23	0.009	0.890
3700 to 3899	27	0.010	0.900
3900 to 4099	22	0.008	0.908
4100 to 4299	25	0.010	0.918
4300 to 4499	9	0.003	0.922
4500 to 4699	20	0.008	0.929
4700 to 4899	13	0.005	0.934
Over 4900	170	0.066	1.000

Session length in minutes

Range	Raw number	Percent	Cumulative
0 to 10	41223	0.354	0.354
11 to 30	27244	0.234	0.588
31 to 50	19780	0.170	0.758
51 to 70	10207	0.088	0.846
71 to 90	5884	0.051	0.896
91 to 135	4935	0.042	0.939
136 to 185	3246	0.028	0.967
186 to 235	1486	0.013	0.979
236 to 285	873	0.007	0.987
286 to 335	443	0.004	0.991
336 to 385	261	0.002	0.993
386 to 435	192	0.002	0.995
436 to 610	266	0.002	0.997
611 to 710	185	0.002	0.998
711 to 810	62	0.001	0.999
811 to 910	33	0.000	0.999
911 to 1010	17	0.000	0.999
Over 1011	66	0.001	1.000

Table 2
Sample Statistics
(Standard error in parenthesis)
Number of Observations in italics

Household	All prices	Limited	Unlimited	All prices Set up fee required
Monthly	18.18 (5.49) *2992*	14.70 (7.17) *841*	19.54 (3.09) *2151*	18.66 (5.94) *603*
Quarterly	17.96 (3.25) *171*	17.09 (3.78) *19*	18.07 (3.18) *152*	18.04 (4.87) *19*
Six Months	16.55 (3.08) *182*	14.36 (4.69) *23*	16.87 (2.65) *159*	17.22 (3.85) *26*
Yearly	14.92 (3.71) *461*	13.59 4.83) *70*	15.15 (3.42) *391*	13.33 (3.92) *43*
Business				
Monthly	30.09 (11.46) *241*	30.44 (19.21) *35*	30.03 (9.61) *206*	31.57 (16.85) *42*
Quarterly	28.81 (11.58) *12*	30 *1*	28.70 (12.13) *11*	36.22 (12.7) *3*
Six Months	19.90 (7.29) *7*	12.41 (5.77) *2*	22.90 (5.67) *5*	16.5 *1*
Yearly	22.03 (7.59) *18*	26.12 (13.96) *2*	21.51 (7.105) *16*	16.25 *1*
Dedicated	116.03 (55.40) *111*			

Table 3
Sub-samples of Monthly unlimited prices
(Standard error in parenthesis)
Number of Observations in italics

	Personal	Business
All Unlimited monthly prices	19.54 (3.90) *2151*	30.03 (9.61) *206*
Offers 1 price schedule	19.03 (3.46) *1271*	22.13 (5.90) *12*
Offers 2 price schedules	19.71 (4.04) *505*	29.57 (7.82) *116*
Offers 3 price schedules	20.80 (4.14) *214*	31.54 (10.89) *31*
Offers More than 3 price schedules	21.42 (5.42) *161*	32.17 (12.24) *47*
Offers any longer contract	19.42 (3.41) *395*	30.72 (9.88) *38*
Offers Hosting	19.47 (3.45) *347*	28.90 (7.13) *43*
Offers Networking	19.58 (3.86) *349*	29.39 (8.36) *40*
Offers Web Design	19.77 (3.89) *622*	30.62 (10.63) *80*

Table 4: Hour limitations

H RS	Freq.	Percent	Cum.
< 5	10	1.24	1.24
5	50	6.2	7.44
6	1	0.12	7.57
7	3	0.37	7.94
8	4	0.5	8.44
9	1	0.12	8.56
10	154	19.11	27.67
11	2	0.25	27.92
12	11	1.36	29.28
13	2	0.25	29.53
15	64	7.94	37.47
20	70	8.68	46.15
25	16	1.99	48.14
30	58	7.2	55.33
35	3	0.37	55.71
40	20	2.48	58.19
45	4	0.5	58.68
50	41	5.09	63.77
60	44	5.46	69.23
65	6	0.74	69.98
75	7	0.87	70.84
80	21	2.61	73.45
85	1	0.12	73.57
90	9	1.12	74.69
99	1	0.12	74.81
100	42	5.21	80.02
120	24	2.98	83
125	3	0.37	83.37
130	2	0.25	83.62
135	1	0.12	83.75
140	2	0.25	84
150	34	4.22	88.21
155	2	0.25	88.46
160	8	0.99	89.45
175	1	0.12	89.58
180	2	0.25	89.83
190	1	0.12	89.95
200	38	4.71	94.67
220	1	0.12	94.79
240	8	0.99	95.78
250	11	1.36	97.15
300	15	1.86	99.01
350	1	0.12	99.13
360	2	0.25	99.38
>400	5	0.6	100
Total	806	100	

Table 4
Descriptive Statistics

Variable	N	Mean	S.d.	Min	Max
Log Price	3166	2.87	0.37	-1.39	5.25
Price	3166	18.71	6.44	0.25	120.00
Length of contract/setup					
Quarterly	3166	0.05	0.21	0.00	1.00
Halfannually	3166	0.05	0.22	0.00	1.00
Yearly	3166	0.12	0.33	0.00	1.00
Setup	3166	0.18	0.39	0.00	1.00
Limited contracts					
Limited	3166	0.24	0.42	0.00	1.00
Onlyonelimited	3166	0.09	0.28	0.00	1.00
Lim60	3166	0.13	0.33	0.00	1.00
Lim50	3166	0.11	0.32	0.00	1.00
Lim40	3166	0.10	0.31	0.00	1.00
Lim30	3166	0.10	0.30	0.00	1.00
Lim20	3166	0.08	0.27	0.00	1.00
Lim10	3166	0.04	0.20	0.00	1.00
Portfolio and sorting					
Notsingular	3166	0.68	0.47	0.00	1.00
Limitedeffect	3166	0.14	0.34	0.00	1.00
Numbereffect	3166	0.21	0.62	0.00	5.00
Maximumeffect	3166	5.74	26.53	0.00	640.00
Billingeffect	3166	0.30	0.46	0.00	1.00
Misc price quote qualities					
Business	3166	0.07	0.25	0.00	1.00
Dateindicator	3166	7.96	5.65	1.00	20.00

Variable	N	Mean	S.d.	Min	Max
Features of the ISP					
Offersdedicated	3166	0.05	0.22	0.00	1.00
Frontier	3166	0.36	0.48	0.00	1.00
T-1backbone	3166	0.89	0.32	0.00	1.00
ISDN	3166	0.67	0.47	0.00	1.00
Complements	3166	0.30	0.46	0.00	1.00
Oldtechnology	3166	0.06	0.23	0.00	1.00
Real	3166	0.17	0.38	0.00	1.00
Games	3166	0.04	0.20	0.00	1.00
Chat	3166	0.05	0.22	0.00	1.00
Video	3166	0.02	0.14	0.00	1.00
Screening	3166	0.01	0.08	0.00	1.00
Economies of scope					
Scope1	3166	0.46	0.50	0.00	1.00
Scope2	3166	0.48	0.50	0.00	1.00
Economies of scale					
Area1	3166	0.50	0.50	0.00	1.00
Area25	3166	0.38	0.48	0.00	1.00
Location					
Rural	2200	0.16	0.37	0.00	1.00
Urban/rural	2200	0.09	0.28	0.00	1.00
Fraction Prof	2200	0.39	0.06	0.18	0.64

End. Variable	Log Price			Log Price			Price level			Price level			Median Price level		
Length of contract/setup															
quarterly	-0.059	*0.025*	**	-0.072	*0.026*	**	-1.23	*0.50*	**	-1.49	*0.45*	**	-1.641	*0.061*	**
halfannually	-0.156	*0.039*	**	-0.162	*0.025*	**	-3.34	*0.38*	**	-3.38	*0.44*	**	-3.242	*0.061*	**
yearly	-0.233	*0.021*	**	-0.246	*0.019*	**	-4.31	*0.35*	**	-4.50	*0.32*	**	-4.000	*0.046*	**
setup	0.039	*0.016*	**	0.039	*0.013*	**	0.64	*0.34*	*	0.74	*0.22*	**	0.061	*0.032*	*
Limited contracts															
limited	-0.049	*0.030*		-0.028	*0.024*		0.32	*0.85*		0.60	*0.41*		-0.014	*0.058*	
Onlyonelimited	-0.073	*0.038*	*	-0.106	*0.022*	**	-1.97	*0.49*	**	-2.29	*0.37*	**	-0.153	*0.053*	**
Lim60	-0.302	*0.109*	**	-0.309	*0.048*	**	-4.29	*1.09*	**	-4.73	*0.82*	**	-4.620	*0.110*	**
Lim50	0.097	*0.124*		0.158	*0.066*	**	0.53	*1.35*		1.44	*1.13*		-0.060	*0.167*	
Lim40	0.019	*0.094*		-0.028	*0.085*		-0.20	*1.29*		-0.62	*1.46*		-0.075	*0.202*	
Lim30	-0.292	*0.130*	**	-0.218	*0.078*	**	-2.53	*1.06*	**	-1.78	*1.35*		-2.051	*0.174*	**
Lim20	-0.054	*0.115*		-0.103	*0.044*	**	-1.26	*0.74*	*	-1.90	*0.76*	**	-2.934	*0.103*	**
Lim10	-0.145	*0.069*	**	-0.154	*0.035*	**	-1.53	*0.54*	**	-1.62	*0.61*	**	-0.100	*0.086*	
Portfolio and sorting															
Notsingular	0.032	*0.018*	*	0.032	*0.018*	*	0.50	*0.42*		0.52	*0.32*	*	-0.002	*0.045*	
Limitedeffect	0.032	*0.032*		0.045	*0.031*		0.22	*1.10*		0.52	*0.54*		0.051	*0.077*	
Numbereffect	0.014	*0.022*		0.018	*0.018*		0.84	*0.83*		0.72	*0.31*	**	-0.161	*0.044*	**
Maximumeffect	0.001	*0.000*	**	0.001	*0.000*	**	0.02	*0.01*	**	0.02	*0.00*	**	0.021	*0.001*	**
Billingeffect	0.013	*0.019*		-0.002	*0.020*		0.15	*0.48*		-0.10	*0.34*		0.077	*0.048*	
Misc price quote qualities															
Business	0.431	*0.029*	**	0.386	*0.021*	**	11.69	*1.05*	**	10.19	*0.36*	**	10.02	*0.051*	**
Dateindicator	-0.003	*0.001*	**	-0.003	*0.001*	**	-0.05	*0.02*	**	-0.05	*0.02*	**	-0.004	*0.002*	*
Features of the ISP															
Offerdedicated	0.064	*0.025*	**	0.035	*0.024*	**	1.35	*0.51*	**	0.75	*0.41*	*	0.132	*0.057*	**
Frontier	0.041	*0.015*	**	0.028	*0.011*	**	0.80	*0.25*	**	0.59	*0.20*	**	0.086	*0.029*	**
T-1backbone	0.034	*0.022*		0.055	*0.017*	**	0.29	*0.32*		0.68	*0.29*	**	0.209	*0.042*	**
ISDN	-0.021	*0.013*		-0.021	*0.012*	*	-0.13	*0.22*		-0.17	*0.21*		-0.00	*0.030*	
Complements	-0.026	*0.015*	*	-0.033	*0.011*	**	-0.20	*0.24*		-0.37	*0.20*	*	-0.01	*0.028*	
Oldtechnology	0.034	*0.025*		0.032	*0.022*		0.65	*0.49*		0.64	*0.37*	*	0.089	*0.052*	*
Real	0.030	*0.019*		0.018	*0.014*		0.68	*0.36*	*	0.41	*0.24*	*	0.021	*0.034*	
Games	0.077	*0.031*	**	0.055	*0.026*	**	0.99	*0.58*	*	0.82	*0.45*	*	0.151	*0.068*	**
Chat	-0.015	*0.030*		-0.021	*0.024*		-0.21	*0.58*		-0.36	*0.42*		-0.08	*0.060*	
Video	0.011	*0.042*		-0.002	*0.036*		0.52	*0.95*		-0.01	*0.61*		0.072	*0.101*	
Screening	0.077	*0.090*		0.017	*0.067*		1.34	*2.00*		-0.04	*1.15*		-0.09	*0.271*	

Economies of scope												
Scope1	0.006	*0.011*		0.010	*0.010*		-0.01	*0.21*		0.12	*0.17*		-0.00	*0.025*	
Scope2	0.000	*0.012*		0.000	*0.011*		-0.04	*0.20*		-0.01	*0.18*		0.02	*0.026*	
Economies of scale												
Area1	0.004	*0.020*		0.007	*0.017*		0.34	*0.33*		0.52	*0.29*	*	0.053	*0.053*	
Area25	0.022	*0.018*		0.017	*0.017*		0.51	*0.31*	*	0.53	*0.29*	*	0.042	*0.052*	
Location												
Rural	0.044	*0.021*	**				1.08	*0.31*	**				0.129	*0.040*	**
Urban/rural	0.043	*0.034*					0.95	*0.37*	**				0.119	*0.045*	**
Fraction Prof	-0.230	*0.143*					-1.97	*1.76*					-0.24	*0.226*	
Constant	2.976	*0.070*	**	2.891	*0.025*	**	18.85	*0.90*	**	18.12	*0.43*	**	19.67	*0.120*	**
R-Square	0.449			0.429			0.48			0.45			0.320		
NOBS	2200			3166			2200			3166			2200		