

Contract Pricing 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 prices for Internet dial-up service at Internet Service Providers (ISPs) from the fall of 1998. This study considers motivations for adopting two common contract provisions, hourly limitations and lengthier contract commitments. Both practices arise because ISPs are passing on cost savings to users, so the more difficult issue is whether market power motivates their use at all. This is also interesting because the use of these practices varies considerably across ISPs. This practice arises more frequently in low density locations where there is less competition. It is also associated with the presence of price discrimination which exploits firm-specific market power. In contrast, lengthier contracts are associated with more competitive situations and not with any pricing patterns which exploit market power. The paper develops implications for understanding contracting practices in mass markets for data communication services.

1. Introduction

This study empirically examines pricing contracts for Internet dial-up service at over 2000 Internet Service Providers (ISPs) from the fall of 1998. These are the contracts for services used for most household on-line activity and some small business use. They form the basis for the mass market for free Internet services, such as news, entertainment, chat and other forms of brochure-ware. ISPs are interesting exception to the rule that few Internet-related activities collected significant revenue at this time. Total revenue reached estimated at three to five billion dollars in the dial-up and direct access markets together at the time of this study (Maloff, 1998).

There is some well known evidence regarding household expenditure for ISP services. Government surveys of ISP use at households find considerable heterogeneity in the prices paid for Internet access.² To be sure, the most common level of expenditure is around \$20/month, but this is far less dominant than assumed in common discussion. From a December, 1998 survey about one third of all households with Internet access report expenditure between \$19 and \$22 per month. Another third report expenditures under \$19 with spikes around \$15 and \$10. The remainder report expenditure above \$22, with spikes at \$25 and \$30, quickly tapering off to levels not exceeding \$50. In other words, households pay a range of prices for Internet access, with close to 90% falling between \$10 and \$30, inclusive.

Why does this variance arise? The government report provides no explanation. Nor does it provide any information about the menu of choices faced by households. Accordingly, the purpose of this paper is to shed light on ISP contracting practices, about which almost nothing is known. I highlight several questions:

- ! What features of the ISP service influence price differences between firms?
- ! What features of the contracts for service determine price variation?
- ! What features of the location in which the ISP offers service plays a role?

² See CPS survey of household Internet use from December 1998. Over 12,000 households report contracts with ISPs at this time.

The study begins by documenting the extent of dispersion in prices, which varies to about the same degree as noted in expenditure data. It then develops an empirical framework for measuring potential determinants of price levels. Specifically, two contracting provisions receive close attention. ISPs vary in their use of two specific contracting provisions, hourly limitations on monthly use and commitments lasting longer than a month. These contrast with the standard monthly contract for unlimited service, the default contracting form. Either contract provision results in a service that is less attractive to users than a monthly unlimited contract offered by the same firm for the same service.

The paper finds that the most important determinants of prices are contract length, hour limitations, and, to some extent, how the ISP arranges its entire menu of prices. The paper also finds that prices differ depending on the contract design – such as default speed and business/home use – and that prices are sensitive to the date of the price quote. Interestingly, there is a little evidence that economies of scale influence price levels, there is no evidence of economies of scope between access prices and related Internet services. For some prices an important factor is whether the ISP offers faster services or games, but, again surprising, many functions which users desire (and which ISPs feature prominently in their marketing) do not explain differences in prices. This includes factors such as an ISP's friendliness, or its ability to support streaming, chat services or screening. Lastly, and related to the point about economies of scale, there is evidence that the density of the location of the ISP influences price levels, but it is surprisingly small for a communications service.

This study informs several different literatures. First, it seeks to identify principals for measuring the value of the economic activity in on-line services and for classifying variation in contracting practices, an unsettled topic for price research about Internet related services. Only a few other empirical papers have examined the pricing of Internet access services, so novelty is high.³ In addition, the industry is young, innovative and changing rapidly, a situation which typically defies easy classification using standard principals for economic measurement.

³ Citation to Stranger and Greenstein (2001) and the price index for Canadian ISPs...

Second, the paper adds to the small list of empirical studies of price dispersion.⁴ This is trickier than it seems since flat rate pricing arises here as a default norm. While this practice also arises in regulated local land-line voice telephony and occasionally in unregulated cellular telephony, it is not usually the focus of empirical studies of price dispersion. Its presence alters the usual approaches to empirically modeling volume discounting and contract restrictions. Moreover, despite many theoretical models exploring the consequences of this feature for ISP conduct and capacity use, no study has performed a census of empirical variants of flat-rate pricing used by ISPs, nor analyzed how ISPs depart from it, nor their determinants. The evidence in this study will frame several issues in this larger debate.

Finally, as with the previous studies on this industry, this research follows a small but growing list of studies which argue that the "new economy" has familiar rules. Is there something special about competitive conduct in the ISP market? The study largely adapts mainstream economic concepts and models to ISP behavior. To be sure, an 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. But economic models here resemble those found in other studies of pricing conduct. As with other studies, a conventional examination here 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.

2. Contract provisions in Internet access

A. Key Features of Supply in 1998

! **A young industry with thousands of entrants:** 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,

⁴ Citation to recent price discrimination studies, such as Borenstein, Rose, Shepherd, Marciano, etc.

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. 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 fall 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.

! **Variation in market structure:** ISPs differed greatly. AOL, AT&T, Mindspring/Earthlink, and many other large ISPs focused on building a large national presence, investing heavily in capital and marketing expenditures. They primarily located in urban areas (Downes and Greenstein, 1999). 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.

Market structure took a very unusual shape. AOL (along with its subsidiary, Compuserve) had signed up something under a half of the households who had adopted in the US. The remainder of households tended to split between big and small providers.

By the time of this study, the industry was regarded as extremely competitive at the national level. However, there was an important split between urban and low-density areas. There were also thousands of regional and local providers of Internet access who served as the links between end-users and the Internet back-bone. Those in urban areas competed with the national firms. There were thousands of these. Those in rural areas largely competed with each other, if anyone at all. Hundreds of small ISPs entered the low density locations which the large ISPs eschewed.

! **Flat rate pricing as default:** By 1998 flat rate pricing had emerged as the predominant default pricing contract. Even AOL had abandoned marginal pricing of many services, moving to flat rate pricing in 1996-97. It was already regarded as the norm for dial-up service at most other ISPs.

According to the usual explanation, flat rate pricing arose for three reasons. First, most dial-up Internet access in the US 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, some observers believe that, as a matter of engineering, it is a hassle for the ISP to monitor data-flows for each user and administer customized billing. This is thought to be especially true for many small ISPs, who find it costly to implement something other than flat rate pricing at the level of the user. Third, many observers thought that users did not like monitoring their own use or being metered in any way. Indeed, some ISPs originally tried metered pricing and soon abandoned it under competitive pressure, adopting unlimited usage for a monthly price. This is consistent with the view that many users simply prefer unmetered use and prefer ISPs who price accordingly (Stranger and Greenstein, 2000).

B. Features of cost & demand which influence pricing

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. 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. 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

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 charges in order to encourage Internet use.

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. In general, individual ISPs tend to face their worse capacity constraints from household demand in modem use and backbone data flows between 8 PM and 11 PM, Monday through Thursday.⁶

ISPs had a variety of instruments for passing on these costs to users. Hence, it is important to understand how those costs are determined and why these plausibly might motivate use of contract provisions. For an ISP who owned and operated its own facilities,⁷ several economic constraints guided the cost structure of providing service.

! **Capacity at ISPs and hourly limitations:** Modem capacity provided a limit on the maximum number of phone calls 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. During this era many users were in the midst of upgrading or 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, but many retained their slower modem banks for times of excess capacity.

Backbone connections were another constraint on the maximum flow of data. If capacity was reached, it translated into slower connection speeds for users, slower web pages downloads and slower response times. The determinants of data flows were complex and varied significantly across ISPs. Data flows are 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

⁶ Surveys show that logins tends to rise at 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.

⁷ 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.

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. Performance criteria in these backbone contracts (e.g., priorities during peak times) are also fixed in the short run and can also influence user experience under some circumstances.

If a user was willing to monitor his own use, then hourly limitations had benefits to both user and ISP. This could be valuable because users varied in the volume of on-line use. Separating users into different groups could support different prices. Low volume users agree to a monthly hourly restriction in exchange for low prices and higher volume users agree to a higher limit and pay higher prices, and so on.

To appreciate why this contract provision could be so valuable, it is important to understand that the distribution of time the average user spent on the Internet was highly skewed, a trend that has continued to this day. For example, in a sample of over 2500 households in the winter of 2000⁸, 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. 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.

In other words, some users made use of the majority of capacity and were *much* more expensive to serve than others. Hourly limitations allow the ISP to charge different prices to these different users, effectively discounting to low volume users.⁹

⁸ For details see Goldfarb [2000] or www.foveon.com.

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

! **Long term contracts and turnover:** 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 and turnover, especially at small firms. 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. A key observation was that the cost of retaining a customer was generally cheaper than the costs of acquiring a new 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.

Long term contracts could be in both the ISP and some user's interest under some circumstances. ISPs who signed users to long term contracts could pass on discounts off the monthly price, limiting potential turnover expenses. At the same time the user sacrifices the option to switch to another ISP. Thus, this contract provisions sorts users between those who are willing to give up the option of moving quickly and those who are not. It works because this option was potentially more valuable to some users than others; after all, this was an era of declining prices and rapidly evolving capabilities.

Both longer contracts and hourly limitations are associated with simple theoretical predictions, i.e., larger price discounts off flat rate prices should accompany more severe restriction. For example, contracts a year should be cheaper than those lasting three months which should be cheaper than those lasting a month. Similarly, contracts with a maximum of 30 hours a month should be cheaper than those for 60 hours a month which should be cheaper than contracts with unlimited hourly usage.

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.

! Other contract provisions: Though there are many other theoretically possible contract provisions¹⁰, in practice dial-up ISPs rarely did much else. In this data there are some examples of business contracts and many variants on higher-speed ISDN contracts, which most households did not want. In addition, free pricing was rare in the 1998, the time at which this study collected data (though it became more available soon thereafter).

Most interesting to economists, ISPs rarely used time-of-day pricing nor any variant on finely metered pricing for data flows over dial-up services. This might seem surprising in light of well known peaks in user demand around certain times of the day and on certain days of the week.¹¹ One explanation is that ISPs found it cheap to "over-invest" in facilities to handle peak loads adequately and this choice was cheaper than experimenting with alternatively pricing plans.¹² Another explanation is that business peak use differs significantly from household peak use, providing ISPs with less of a peak load issue than first meets the eye.¹³

! Services related to access and the standard contract: There were many other fixed and variable costs to running a small 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 better backbone facilities. In addition, other 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.

¹⁰ See McKnight...

¹¹ The following is a crude summary of household demand over the time of day, but enough for this paper's purposes, which is to discuss capacity use. Foveon measures the time between new page refreshes. Peak demand is associated with the highest number of new pages. For example, for the Foveon sample, the highest 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.

¹² "Over-investment" in caching, reserve capacity, and related capital is one way to handle peak-load demand without abandoning flat-rate pricing. It is an open question whether, in the presence of different pricing practices, contracting practices are substitutes or complements to investment practices on the margin. The first-best and second-best efficiency of this behavior is also open to question. See, e.g., Mackie-Mason and Varian, or Sidek and Spulber.

¹³ Small business use varies over the business day, falling off during the evening, which is precisely when office use peaks.

During this era ISPs faced many unsettled questions about what to bundle in the standard contract and what to charge for separately. The standard contract for dial-up service, which this paper focuses on, tends to come bundled with a wide variety of un-priced services, such as email account functions, games, home-page links, standard servicing, local news and other costly custom features. Many ISPs boast about their connection speed, modem availability, and other service guarantees which are costly to meet, but whose costs are implicitly bundled in the price of basic service. Many ISPs charged separately for a variety of additional services, such as hosting on a large scale and many charged separately for consulting extensive services. Many charge set-up fees for basic service and many ISPs do not charge set up fees at all.

! 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. Dense urban areas contain many suppliers from a wide variety of backgrounds, while less dense areas contain few suppliers, fostering differences more competitive pressure in the urban setting than the rural setting.

Urban markets have more supplies of services. This arises from two factors. Economies of density lowers delivery costs and larger market size supports greater numbers of finely differentiated suppliers. These factors also tend to correlate with the presence of modern communications infrastructure. Hence, price levels should be lower in urban markets. Since national suppliers disproportionately locate in urban areas, this factor should also lead to lower prices at national ISPs. Moreover, if competitive pressures induce ISPs to sort between users, then more competitive settings in urban markets should yield more finely grained sorting of contract practices. If market power underlies the use of contract sorting mechanisms, then less urban settings should experience more sorting behavior.

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 in 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 about contracting practices.¹⁴ 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

¹⁴ 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*.

them to users in an attractive way. So this data must necessarily under-report on reality. As explained below, it is possible to control for some of these distortions and, more to the point, the observed behavior will be consistent with predicted economic conduct, so we will infer that these quotes reflect a real phenomenon.

The pricing and contract data is relatively novel. Only a few papers have tried to relate pricing to the basic functionality offered by ISPs.¹⁵ 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 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 in the summer of 1998.

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. Most ISPs contain much more, such as the functionality necessary for supporting web use. The data set 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).

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 is slightly higher than previous counts because this later census (on the part of my RAs and me) resulted several hundred more observations of ISPs (mostly new entrants) for whom we could get complete data on service lines.

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

¹⁵ Citation to the price index for the Canadian ISPs, Stranger and Greenstein (2001).

variety of reasons, either because their normal contract is for a savvy business user or prices vary for a number of different bundles. Controls for this behavior will be tested below. 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 pattern 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. 1,026 ISPs quote more than one price schedule for business and household use and often these quotes include enormous detail.¹⁶

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 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 constraint is the absence of a non-coarse measure of quantity. There was no comprehensive information about measure market share between ISPs or between different contracts offered at the same ISP.

B. A first look at contracting provisions

I first examine pricing using simple descriptive statistics and unconditional comparisons in order to assess the plausibility of the data set. Overall it will confirm several simple relationships between

¹⁶ 24.2% quote two price schedules, 9.9% quote three, 5.1% quote four and 2.0% quote five or more.

prices and contract provisions.

Table 1 displays a summary description of the variation in pricing. The first three columns of Table 1 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, but can also come with limitations on hourly use or service times.¹⁷ Table 1 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.

Overall, 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. 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.

! *Contract commitment and length:* Table 1 confirms the simple prediction that 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 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.

¹⁷ 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.

Average monthly unlimited prices are \$30.03, quarterly are \$28.70, half-yearly are \$22.90 and yearly are \$21.51. The standard deviation is generally around \$9 in this category, again leading to a weaker inference.

! *Hour limitations:* Table 1 also confirms the standard prediction that prices differ between the limited and unlimited contracts in household contracts. 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.

Table 2 presents 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.¹⁸ 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 -- i.e., in other words, the types of users who make up the vast majority of dial-up users in this time period.

The correlation between these monthly prices and the numerical value of the hour limitation is 0.49, which is high and positive, as expected. 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. This is suggestive of pricing separation, but far from conclusive.

Also informative is information about the highest hour limitation at an ISP (when it is known).

¹⁸ 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.

This also follows a skewed pattern, obviously. 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 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.¹⁹

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.²⁰ 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.²¹ Indeed, by 1998 the prices for additional hours were so high in so many instances that they appear to serve the purpose of punishing users for exceeding the hourly limitation rather than metering much actual use (Stranger, 2000). This is consistent with reports in the trade press that metered use largely disappeared due to its unpopularity with users and has not been widely seen since the first few years of competition in the industry.

! *Miscellaneous features of the contract:* Table 1 contains a column with prices in which the ISP asks for a set up fee (approximately 18% of the price quotes). Installation fees average \$20 (s.d. =

¹⁹ 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.

²⁰ 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.

²¹ 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.

\$8.60) for the non-dedicated, household contracts. Table 1 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.

Installation 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, 77.8%, 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.

Table 1 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, though it is also possible for them to carry certain limitations too, such as service during business hours or non-negotiable monthly limitations on total hours. 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.

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 on *thelist*. By definition this date tells us about the most recent date at which the ISP filled out the survey on *thelist*.²² *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

²² 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.

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. At the least, it suggests that we must control for date of quote.²³

4. Exploring the importance of location

For testing the importance of location this study examines a subset of small and medium-sized ISPs for whom it was possible to characterize the location of the ISP's service. This involves 1,497 ISPs.²⁴ 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. 966 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. These settings are relatively different; all urban areas are extremely competitive, while some rural areas are not.

It is also possible to count the number of local competitors in rural areas. A subset of the 223 ISPs come from especially uncompetitive market conditions.²⁵ 70 ISPs have monthly unlimited prices and are located in counties with 2 to 4 total competitors, and 53 face only 1 or fewer competitor in their

²³ 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.

²⁴ 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 against approximately 5,400 ISPs in the Downes and Greenstein [1999] who were in five or fewer counties. *The directory* 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.

²⁵ This is a bit coarse since, as done in Downes and Greenstein [1999], this does not control for competition coming from "neighboring" counties. Nonetheless, it still provides a reasonable approximation of the influence of market structure on price.

county.

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 the motives for using lengthier contracts and contracts with hourly limitations.

! **Prices:** How do price levels vary with density of location? This is a bit difficult to do in a standardized way. As a coarse first pass at the data, I examine the 1292 personal monthly unlimited price quotes.²⁶ The strength of this comparison is that it avoids aggregating apples and oranges. Its weakness is that it does not use all the data. For now, we only examine monthly unlimited prices to develop a feel for the data.

The urban price levels for monthly unlimited prices average \$19.35 (s.d. = \$3.67). The mixed average are \$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 increase with density and competitive setting. This is consistent with the presence of economies of density in urban areas and the importance of more competitors in urban areas.

Focusing at rural ISPs it is possible to examine if prices are sensitive to uncompetitive market conditions. The monthly unlimited prices are \$21.46 (s.d. = 4.23) and \$22.00 (s.d. = 5.27), respectively, for ISPs with 2-5 competitors and for ISPs with 1 or none. This is higher than the overall average for rural areas, which reinforces the trend, though not by much. Since lower competitiveness is coincident with lower density, these higher prices could be both evidence of higher costs and the use of

²⁶ Not all 1497 ISPs quote unlimited prices, so not all firms in the location data set are included.

market power.

! **Hour limitations.** Table 3 presents information on the use of contracting provisions in different market structures, as a direct test of locational sensitivity. This presents data on all 1497 ISPs for who geographic information is known. The columns are divided between the difference market structures and firm size. Firm size is included as another proxy for the influence of location. Small ISPs mix urban/rural locations, while large ISPs are primarily located in urban areas. The rows provide information about different contracting provisions. The cells provide information about the frequency of use of these contracting provisions. The unit of observation is an ISP.

The top three rows describe use of different hourly limitations. The top row indicates whether the ISP offers any contract with an hourly limitation. The second row indicates whether the ISP offers any contract without limit. The third row indicates whether an ISP offers both an unlimited and limited contract. The first and third row are part of the first test for market power motives behind hourly limitations. The findings are consistent with such an interpretation. 23% of ISPs in urban areas offer limited contracts, while 35% of those in rural areas do. In the less competitive rural areas it is even higher (42%). A combination of limited and unlimited contracts is offered by 14% of the ISPs in urban areas, but 27% of those in rural areas (in mixed areas it is 30%), with no difference across the rural markets.

Small firms use these provisions more frequently than large firms (e.g., 29% versus 17%). Since these are the very same firms who have national presence (overwhelmingly and primarily in competitive urban areas), the absence of such contracts at large firms again is consistent with the absence of market power at large firms. This is also consistent with the view that market power will arise due to local isolation in rural markets, not anything associated with branding.²⁷

! **Length of commitment:** The information about contract length is not very informative about economic variation over location. Similar to the above, rows 4-6 present information about the

²⁷ Arguably, this result could also arise partly as an artifact of the data construction. AOL and Compuserve are only two observations among the national firms, the vast majority of whom may not possess market power.

propensity to offer a monthly contract, an ISP who offers a contract longer than a month, and an ISP who offers both of these. Monthly contracts are more common in less competitive environments (93% versus 96%), longer contracts are less common (23% versus 18%), and combinations are mildly more common in competitive markets (16% versus 14%). The information on the least competitive markets reinforces the findings. If anything, the use of longer contracts increases in more competitive market settings, but the tendency is weak.

The information about the use of longer contracts by smaller/larger firms is somewhat contradictory. The trend is towards less use of longer contracts by larger firms (21% versus 14%) and fewer firms offering combinations (14% versus 8%), but the trends is not particularly monotonic among the middle-sized ISPs.

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 vendor offer discounts more frequently through longer contracts, in the other through volume limitations.

5. Measuring the determinants of price variation

Below are regressions relating contract price levels to exogenous variables. 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 and both 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 correlated, such as economies of density and scale. This is an entirely appropriate approach for examining data which has not been previously examined.

Table 5 lists the descriptive statistics for the main variables. These are comprised of all business and household price quotes for which there were no missing variables on essential features of

the price schedule (such as hourly limitations) and features describing the ISP (such as date of record). There were 3068 such price quotes from 1926 ISPs.²⁸ Of these, 2234 prices come from 1497 small and medium ISPs whose location is known. Since the results did not largely differ using the geographic data, the paper only presents evidence using the large set of data.²⁹ That is, rural prices are generally higher, but there is a similar relationship between price levels and the other determinants across multiple regions.

A. Exogenous variable definitions

The regression on prices will use many variables. Some are of primary interest, such as the contracting terms. Some are included as ways to check for the importance of other factors or to rule out competing interpretations. These variables are specified as follows:

! *Limited contracts*: **Limxx** are dummies measuring the range of the hourly limitation per month. For example, **Lim5-10** is one if the hourly limitation is for 10 hours or less per month, **Lim11-20** is one if it is for 11 to 20 hours per month, and so on to 60. Due to small cell size, there is one dummy for 61 through 100 hours, and one dummy for over 100 hours, which is virtually an unlimited contract for all but the most intense user. I use dummies instead of a continuous function of hours because the data on hours, as shown in Table 2, is quite spiked at certain points. The relationship is also quite non-linear, which this form picks up easily.

! *Length of Contract*: **Quarterly**, **half-annually** and **yearly** are dummy variables representing contracts that required 3, 6 or 12 month commitments. **Monthly** is omitted.

! *Pricing portfolios*: As noted, ISPs differ in their willingness to offer variety of services, a factor that may cloud the interpretation of how contract features influence prices. Several variables are

²⁸ Obtaining information about the date indicator and hourly limitations was the largest constraint on the sample size. All missing observations were dropped. This sample also excludes 10 observations where hourly limitations are between 1 and 4, which appear to be rates for hourly service.

²⁹ Overall prices are higher at rural ISPs, but this control does not largely alter the estimates of price separation. The results are included in the appendix.

included as a measure of this motive. **Onlylimited** takes a value of one if this ISP only quotes limited prices; it is zero otherwise. **Onlyunlimited** takes a value of one if the ISP only quotes unlimited prices; it is zero otherwise. Similarly, **Onlyshort** takes a value of one if the ISP only quotes monthly prices and nothing longer. **Onlylong** takes a value of one if the ISP only quotes prices longer than a month. These variables help identify the difference, if any, between those firms who quote a combination of prices with a combination of contract provisions and those who do not. The omitted contract is from ISPs who quote limited, unlimited, monthly and long term contracts.

Related, contract features for close substitutes should influence pricing, but distant substitutes should not. **Max10-100** interacts the maximum hourly limit with the monthly unlimited dummy. If price is a monthly unlimited contract and the maximum hourly limitation is between 10 and 30 hours then **Max10-30** is one, zero otherwise. Similarly, for **Max40-60**, **Max60-100** and **Maxabove100**. These dummies could not be made smaller due to cell size. Similarly, **Billquart**, **Billhalf**, and **Billyear** are dummies for how offering contracts of different length influence monthly unlimited prices.

! *Service bundle and quality*: **Set-up** is a dummy representing whether the price schedule included a setup fee. **Business** is a dummy for whether the contract is a business quote or not.³⁰ **Multi-email** is a dummy for whether the ISP supports only one email account. It is one if the ISP advertises that they support more than one.³¹ **Slow28** and **Fast56** are dummies for whether the ISP advertises either 28-34k or 43-56k service. The omitted variable is the ISP leaves it unstated. **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. **Furtherinfo** is a dummy for whether the ISP advises phone or look at their web page for further information. It corrects for any reporting biases associated with the survey method, if any.

³⁰ 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.

³¹ It is a bit unclear why ISPs advertise their support for multiple email accounts, since any reasonably sophisticated user can usually work around any such constraint. However, novice users may not be able to do so, and they were the majority of users during the time period.

! *Features of the ISPs:* Most of these try to measure the quality of service at an ISP. The first four control for the engineering capabilities of the 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.³² **ISDN** is a dummy for whether the ISP 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.³³ 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.³⁴ **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.

Two additional dummies indicate whether the ISP discusses any additional services -- either networking, hosting or web design, as discussed in Greenstein (2000a). 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.³⁵ Economies of Scale is represented by 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.

³² 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.

³³ These formed the basis for **handholding** in Greenstein [2000], which also looked an ISP's propensity to advertise capabilities toward unsophisticated users.

³⁴ 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.

³⁵ 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.

B. Descriptive Results

Regression results are in Table 5, where the unit of observation is a particular price with a particular set of contracting terms. Since most of the exogenous variables are dummies, there were only a few ways to experiment with the specification. Box-cox tests did not provide conclusive evidence for the form of the endogenous variable.³⁶ Hence, I show both estimates. The first column uses the level of prices as the endogenous variable. The second column uses the log of prices as the endogenous variables.³⁷ Not surprisingly, estimates of random effects models reject the null that the ISP-specific error is uncorrelated with the exogenous variables, so there was little benefit to using the modest panel features in this data set.³⁸ Hence, the two columns show only OLS estimates with the White correction for heteroscedasticity.³⁹

The fraction of variance explained by these simple regressions exceed 49%. 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. In a nutshell, it is possible to explain a high fraction of a price by knowing the contracting terms. Indeed, a regression on contracting practices alone almost explains as large fraction of variance.⁴⁰ This is remarkably successful for a cross-sectional regression.

! *Limited contracts:* **Limxx** demonstrate the range of discounts associated with hourly limitations. The discounts are quite substantial, even for a limitation to 100 hours, which estimate a

³⁶ The box-cox lambda estimates between .44 and .47, depending on specification. It does not lead to a strong recommendation for either log or linear specification, providing no ready interpretation. This contrasts with Stranger (2000), in which there is strong evidence for using the log of price as the endogenous variable.

³⁷ At this time we found only one example of a "free" ISP. This observation was omitted.

³⁸ The panel is quite unbalanced, since so many ISPs have only one price. Hence, the ISP-specific error is plausibly correlated with exogenous variables leading to the adoption of more than one price. In particular, testing for price separation requires including dummies for only one type of contracting form, an action which is closely related. Of course, fixed effects cannot be estimated, since it will not estimate any ISP-specific trait.

³⁹ That said, 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.

⁴⁰ 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 the variance of prices.

\$2.60 discount in the first column or 15% discount in the second estimate. Generally, the discounts become large as the hourly limitation becomes more binding. A 20 hour limitation is worth a \$9.95 discount in the levels estimates or 65% the log estimates.

The results are mildly deceptive if not interpreted carefully. This discount easily falls in the range of 25% to 50%, but rarely more than that. The largest measured discounts due to hourly limitations disproportionately show up on monthly contracts, if at all, and rarely on longer contracts. 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.

! *Length of Contract*: **Quarterly**, **half-annually** and **yearly** have their anticipated benefit compared with monthly contracts. There is a 1% discount for a quarterly contract which is not statistically significant, a 9% discount for a six month contract and a 18% discount for a yearly contract. These are estimated as \$0.68 (also not significant), \$2.31 and \$3.69 in the estimate on levels. These are large and important.

! *Price separation*: The estimates for **limitedonly**, **unlimitedonly** and **longonly** are significant in both columns. **Max60-100** and **Maxabove100** are also significant, though only **Billquart** is among the three for contract length. The estimates for **limitedonly**, **unlimitedonly**, **Max60-100** and **Maxabove100** are particularly large, which will lead to relatively large estimates for price separation.

The limited and unlimited prices are quite close to each other for very high hourly limitations, consistent with the view that they are close substitutes. Yet, the coefficients for **onlylimited** and **onlyunlimited** together exceed this difference, which is somewhat implausible. There is little difference between the prices for those with only long contracts, only monthly contracts or both.

! *Miscellaneous*: **Setup** is significant and generates a modest increase in price, consistent with the view that initiation fees may measure unobserved quality at the ISP level. **Business** contracts command a high premium. Controlling for other factors, these contracts tend to be at least 39% higher or \$10.40. Advertising more **Email** accounts command a modest premium, as does advertising faster modem speeds.

The two reporting variables are interesting. **Dateindicator** is important. The difference over twenty months amounts to a 6% decrease in prices or approximately \$.90 in the estimates on levels, 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. There is no effect on price if the ISP recommends the reader to the ISP's home page, as indicated by **Furtherinfo**.

! *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 are modest. The other measures of engineering capability, **T-1backbone**, also is important.

Most other features of ISP do not influence prices and are not presented. **ISDN**, **Complements** and **Oldtechnology** give inconsistent and weak estimates. **Real**, **Chat**, **Video** and **Screening** do not influence prices. Only **Games** appears to have a modest influence and it is not significant in both estimates. There was no evidence of economies of scope. The evidence for economies of scale is weak, at best. Both **1areacode** and **2-5areacode** are small and significant in the levels estimates, but insignificant in the estimate using logs of prices.

! *Overall assessment*: 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. 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.

6. Interpreting the results

! Price index construction: These results have positive implications for the construction of price indices for Internet access. That is, a price index only needs to have sample on a small and deliberate set of features of contracts -- their hourly limitations, the length and a few features of quality. We can see this in two results.

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

Second, it is also possible to explain some fraction of higher prices due to ISP quality. 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.

! How to frame price conduct: There are many intriguing similarities and differences between ISPs and other communication markets. There is one obvious similarity: High volume users pay less per hour than low volume users. However, hour limitations work on different principles here, since high volume use is not finely metered and violation of contracting limitations can involve significant expense.

These 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 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 some users have a distaste for such limitations. Moreover, competitive pressures might prevent ISPs from using them often.

The traditional way of summarizing communications prices provides a way to frame these hedonic estimates. While this framing is incomplete, it suggests a simple and useful way to summarize the pricing of Internet access in the United States during this time. The traditional view distinguishes between the "connection charge" and the "usage charge."

Here, the connection charge is a substantial part of use cost. A 10 hour monthly contract approximately cost \$8.50, a 20 hour contract \$10.50. The difference between this contract and unlimited contracts (100+ hours) was approximately between \$12.00 and \$10.00. So the usage charge is approximately \$0.10 to 0.12 a hour, on top of the connection charge. Since most users had local telephone service already and most pay flat rate usage charges for local service, these two ISP expenses form the primary cost of access to most non-rural households.

! International comparison: From almost any perspective \$0.12 is an extraordinarily cheap usage charge. It is much cheaper than the typical usage charge for long distance telephony in the United States. More to the point, it is cheaper than local usage charge in almost all western countries, where a cent for five minutes is almost unheard of.

From a user's perspective the US system has an almost unique characteristic. The addition of any usage charge for local telephone service makes it is virtually impossible for any non-US western

telephone system to replicate the US Internet access pricing structure. Related, one would expect non-US access providers to try to reduce usage charges as a way to attract customers, as, for example, happened in Britain (citation needed here).

This also raises another open question. Did the low usage charge in the US contribute to high rates of adoption of Internet access in the United States?

! Further research: These results also frame another puzzle. The vast majority of users are well underneath 100 hours per month. These users would benefit from a monthly contract which distinguishes between a connection and usage charge. Yet, no ISP offers such a contracting form. Why not? Perhaps the monitoring costs to users or ISPs is sufficiently large or onerous that both parties prefer simple monitoring schemes. This explanation would suggest that the absence of usage charges, therefore, implicitly embeds the removal of an additional cost to Internet access operations which other non-US ISPs otherwise incur.

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. The absence of this feature in competitive markets poses some interesting questions regarding the optimal menu of contract limitations. Finely metered pricing may achieve efficiencies in some facets of network operations, but impose disutility on users which otherwise goes unmeasured. This raises an intriguing question about whether private markets achieve second best solutions in the absence of fine metering.

Finally, these results motivate a related line of questioning: why do some ISPs offer multiple 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? These are open questions for further work. To be sure, there is circumstantial evidence of price discrimination -- i.e., in pricing that looks like it seeks to sort users between different limitation and in the influence of limited prices on unlimited prices. However, there is plenty of other important evidence with no such interpretation -- i.e., contract length, business bundles, setup fees, and the returns to ISPs with engineering capabilities. Each of these has a ready cost-based explanation and interpretation. Urban/rural differences in prices is ambiguous. Similarly, a

dollar difference in urban/rural prices, even controlling for other factors, could quite plausibly be attributed to economies of density or to market power at rural ISPs where the market power influences all prices and it otherwise goes unmeasured.

Table 1
 Sample Statistics
 (Standard deviation in parenthesis)
Number of Observations in italics

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

Table 2: 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 3
Frequency of use of Contract Provisions

ISP offers	Only Urban	Both urban & rural	Only rural	Rural with 2-4 rivals	Rural w/ 1 or no rivals
Limited	0.23	0.37	0.35	0.36	0.42
Unlimited	0.91	0.93	0.92	0.91	0.87
Both limited & unlimited	0.14	0.30	0.27	0.28	0.29
Monthly	0.93	0.97	0.96	0.98	0.98
Longer than one month	0.23	0.20	0.18	0.15	0.16
Both monthly & longer	0.16	0.18	0.14	0.13	0.15
Number of ISPs in category	1129	113	255	80	62

ISP offers	One Area Code	2-5 Area Codes	6-20 Area Codes	More than 20 Area codes
Limited	0.29	0.25	0.26	0.17
Unlimited	0.91	0.90	0.88	0.92
Both limited & unlimited	0.20	0.15	0.14	0.09
Monthly	0.94	0.93	0.96	0.94
Longer than one month	0.21	0.24	0.24	0.14
Both monthly & longer	0.14	0.17	0.20	0.08
Number of ISPs in category	963	769	161	109

Table 4
Descriptive Statistics

Category	Variable	Mean	St. Dev.
Hourly Limitations	Lim5-10	0.057	0.233
	Lim11-20	0.038	0.192
	Lim21-30	0.020	0.141
	Lim31-40	0.005	0.072
	Lim41-50	0.011	0.105
	Lim51-60	0.013	0.112
	Lim61-100	0.023	0.149
	Lim100+	0.043	0.203
Length of Contract	Quarterly	0.046	0.210
	Halfannually	0.049	0.216
	Yearly	0.118	0.322
ISP Contracting Practices	Limitedonly	0.064	0.245
	Unlimitedonly	0.648	0.478
	Onlyshort	0.648	0.478
	Onlylong	0.027	0.163
Price Separation in Hourly Limitation	Max110-30	0.065	0.247
	Max140-60	0.018	0.133
	Max160-100	0.008	0.088
	Maxabove100	0.012	0.108
Price Separation in Contract Length	Billquarter	0.036	0.187
	Billhalf	0.041	0.199
	Billyear	0.096	0.295
Miscellaneous Influences on Prices	Setupfee	0.189	0.392
	Business	0.066	0.247
	Multi-email	0.932	0.253
	Slow28	0.080	0.272
	Fast56	0.114	0.318
	Dateindicator	7.938	5.637
	Furtherinfo	0.044	0.205
Engineering Capabilities of the ISP	Offersdedicated	0.049	0.215
	Frontier	0.351	0.477
	T-1backbone	0.885	0.319
	Offers ISDN	0.661	0.473
Other ISP Services Offered With the Standard Bundle	Complements	0.296	0.457
	Oldtechnology	0.059	0.236
	Real	0.171	0.377
	Games	0.044	0.206
	Chat	0.052	0.223
	Video	0.022	0.145
	Screening	0.006	0.074
	Scope1	0.537	0.499
	Scope2	0.512	0.500
	1areacode	0.502	0.500
2-5areacodes	0.375	0.484	

Table 5
Coefficient Estimates

Variable	Price			Log(P)		
	Coef	S.e.	Sig	Coef	S.e.	Sig
Lim5-10	-12.00	0.562	**	-0.871	0.040	**
Lim11-20	-9.953	0.611	**	-0.656	0.047	**
Lim21-30	-8.004	0.771	**	-0.553	0.086	**
Lim31-40	-5.551	0.944	**	-0.300	0.065	**
Lim41-50	-5.348	0.819	**	-0.291	0.047	**
Lim51-60	-6.863	0.939	**	-0.459	0.087	**
Lim61-100	-2.609	0.910	**	-0.150	0.042	**
Lim100+	0.017	0.880		-0.050	0.039	
Quarterly	-0.683	0.598		-0.010	0.045	
Halfannually	-2.361	0.505	**	-0.092	0.051	*
Yearly	-3.690	0.492	**	-0.185	0.044	**
Limitedonly	2.014	0.530	**	0.109	0.033	**
Unlimitedonly	-2.030	0.482	**	-0.090	0.022	**
Onlyshort	0.566	0.437		0.045	0.041	
Onlylong	-0.622	0.381	*	-0.052	0.026	**
Max110-30	-0.230	0.590		0.000	0.026	
Max140-60	1.934	1.324		0.066	0.041	
Max160-100	1.940	1.067	*	0.092	0.043	**
Maxabove100	4.212	1.353	**	0.170	0.051	**
Billquarter	0.837	0.527		0.052	0.024	**
Billhalf	0.319	0.468		0.029	0.021	
Billyear	0.177	0.489		0.018	0.037	
Setupfee	0.593	0.254	**	0.031	0.013	**
Business	10.486	0.815	**	0.395	0.020	**
Multi-email	-1.071	0.437	**	-0.043	0.020	**
Slow28	-0.485	0.299		-0.057	0.019	**
Fast56	-0.391	0.218	*	-0.004	0.016	
Dateindicator	-0.045	0.014	**	-0.003	0.001	**
Furtherinfo	-0.059	0.412		0.001	0.024	
Offersdedicated	1.183	0.410	**	0.070	0.024	**
Frontier	0.504	0.205	**	0.020	0.012	*
T-1backbone	0.953	0.248	**	0.068	0.017	**
Offers ISDN	-0.114	0.188		-0.015	0.012	
Constant	20.525	0.880	**	2.985	0.048	**
R-Squared	0.491			0.501		

These estimates control for complements, old technology, real, games, chat, video, screening, scope1, scope2, 1areacode and 2-5areacodes.