

# Contracting 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 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. They form the basis for the mass market for free Internet services, such as news, entertainment, chat and other forms of brochure-ware. Close to a third of US households had contracted with an ISP for dial up service by this time and surveys showed no uniformity in the prices paid (CPS, 1998). These firms are interesting because few Internet-related activities collected significant revenue at this time. Internet access was an important exception, reaching revenue estimated at three to five billion dollars in the dial-up and direct access markets together (Maloff, 1998).

This study explores the motives for using 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. As discussed in the paper, both practices could be consistent with the ISP passing on some cost savings to the user. In addition, both provisions could be instruments for second degree price discrimination if some users strongly dislike the feature and the ISP has market power.

The study begins with a discussion about how the operations of an ISP motivates use of different contract provisions. It provides explanations for why ISPs use lengthy commitments and hourly limitations. Simple models forecast that more constraining hourly limitations or longer contracts reduce costs to an ISP. This translates into discounts off monthly limited contracts which increase as the provisions become more severe, a prediction borne out in the data.

The study next considers evidence about the use of these provisions in areas with different market structures, a natural experiment in this data. That is, if the contracting provision exploits market power for purposes of price discrimination, then the firms located in less competitive settings should use the provision more frequently. In particular, rural areas are less competitive than urban areas for ISP service, so the hourly limitations should increase as we move into more

rural areas. The study finds evidence that the use of hourly limitations is consistent with market power. The study finds contradictory and weak evidence that this motive is associated with commitment length.

Since this first test is suggestive but inconclusive, the study ends with two more statistical tests, each examining the effect of these contract provisions on pricing. In particular, it first looks for pricing separation. That is, if the two types of contract provisions are being used as instruments of price discrimination to exploit market power, then the difference in prices should internalize the firm-specific cross-price price elasticity, pushing the prices apart. This test for price separation resembles Shepherd's (199?) examination of pricing at gasoline stations. As there, ISPs can offer a high quality and low quality service, and there are ISPs who offer both or one of each. Similarly, we never observe the same firm discriminating and then not, so the empirical test for price discrimination compares across firms who otherwise do not offer the same service.

There are special challenges to implementing this test in this context. The service here is quite complex and contracting practices vary across ISPs. ISPs also differ in basic features, such as the amount of capacity and other services, all of which needs to be controlled for. Finally, the logic of the first statistical test suggests a novel additional test: close substitutes should exhibit more price separation (in a sense defined below) than more distant substitutes. This last observation motivates the last statistical test, which holds for hourly limitations and not commitment length.

Overall, the study finds evidence that the use of hourly limitations is consistent with the exploitation of market power. This arises most frequently in rural and low density markets, further evidence that rural ISP service is not as good as urban service (Downes and Greenstein, 1998, Greenstein, 2000b). In contrast, the study finds that the use of lengthy contracts is consistent with the presence of competitive pressure to pass cost savings on to users. There is little evidence to suggest that this provision arises due to the exploitation of market power.

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.<sup>2</sup> The task is also challenging because flat rate pricing is common in this industry; this practice frames several methodological challenges described below. In addition, the industry is young, innovative and changing rapidly, a situation which typically defies easy classification using standard principals for economic measurement.

Second, the paper adds to the small list of empirical studies of price dispersion and price discrimination, in particular.<sup>3</sup> This study offers two principal novelties for this literature. For one, the situation motivates use of some novel statistical tests. No previous work has used statistical tests which exploit locational differences in the propensity to use contracting provisions, nor has any work ever developed a test for increasing price separation. Second, 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.

Third, the study addresses some concerns about the influence of flat rate pricing on the efficient use of access facilities. 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.<sup>4</sup> However, 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. This is a gap in the literature. 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

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<sup>2</sup> Citation to Stranger (2000), Greenstein (2000c) and the price index for Canadian ISPs...

<sup>3</sup> Citation to recent price discrimination studies, such as Borenstein, Rose, Shepherd, Marciano, etc.

<sup>4</sup> For reviews see Mackie-Mason and Varian, McKnight, Whinston, Sidek and Spulber...etc.

growing list of studies which argue that the "new economy" has familiar rules.<sup>5</sup> 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**

Government surveys of ISP use find considerable heterogeneity in the prices paid for Internet access.<sup>6</sup> Consistent with popular perception, the most popular contract is around \$20/month, but this is far less dominant than commonly assumed. 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. The government report provides no explanation for why prices differed so much across households.

Using data similar to that used in this study, Greenstein (2000c) reports considerable heterogeneity in the prices offered by ISPs (A flavor of these findings are reported below). Using hedonic methods, this study showed that ISP prices were largely determined by features of the contracts for ISP service, and, secondarily, by features of the ISPs offering the service. Features of the location in which the ISP offers service also plays a role. In that study, the findings were used to develop principals for constructing price indices. Those results also motivate a closer

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<sup>5</sup> Citations to (Greenstein, 2000b, 2000c), Brynolfsson, etc.

<sup>6</sup> See CPS survey of household Internet use from December 1998. Over 12,000 households report contracts with ISPs at this time.

examination of the reasons for observing specific contract provisions, the topic of this paper.

This study focuses on understanding contract limitation (on hours per month) and contract length (above a month). I use many types of evidence to understand these provisions. The first evidence is institutional and largely circumstantial, involving a discussion of the cost structure of ISPs and common features of demand. I will argue that both contract provisions plausibly could be consistent with the cost savings and with the use of market power. This discussion will also inform the statistical tests below.

#### *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, 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.<sup>7</sup> Second, as a matter of engineering, it is a hassle for the ISP to monitor data-flows for each user. In particular, many small ISPs find it costly to implement something other than flat rate pricing at the level of the user. Third, and perhaps most significantly for this study, 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

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<sup>7</sup> 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.

and prefer ISPs who price accordingly (Stanger, 2000).

*B. Features of cost & demand which influence use of contract provisions*

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 ISP'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. In general, individual ISPs tend to face their worse capacity constraints in modem use and backbone data flows between 8 PM and 11 PM, Monday through Thursday.<sup>8</sup>

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,<sup>9</sup> 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

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<sup>8</sup> 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 its 8AM level. Friday through Sunday tend to have similar patterns over the day, but at substantially lower levels.

<sup>9</sup> 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.

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 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 2000<sup>10</sup>, 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

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<sup>10</sup> For details see Goldfarb [2000] or [www.foveon.com](http://www.foveon.com).

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.<sup>11</sup>

! **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

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<sup>11</sup> 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.

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, confirmed in the hedonic estimates found Greenstein [2000c] and replicated in modified form below -- 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. These predictions complicate the test of price separation, as noted below.

**! Other contract provisions:** Though there are many other theoretically possible contract provisions<sup>12</sup>, 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.<sup>13</sup> Aside from the conventional explanations offered above, one additional 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.<sup>14</sup>

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<sup>12</sup> See McKnight...

<sup>13</sup> 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. 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.

<sup>14</sup> "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

! **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.

There were 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 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. This variety will complicate the statistical analysis below.

### 3. Statistical tests

The study next develops three statistical tests about contracting provisions. The first statistical test examines the frequency of use of the instrument across different market structures. The second test looks at the differences in prices between ISPs who sort their users by using contract provisions and those who do not. The third test looks at the sensitivity of that difference to the type of sorting. Before discussing the provisions at length, the latter tests are explained in their generic form below. This will fix the basic economic framework and give a sense of how the study will build its evidence.

! **Notation:** Consider a standard model of second degree price discrimination. Assume an ISP potentially has use of a single contracting provision for potentially separating users into two

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and second-best efficiency of this behavior is also open to question. See, e.g., Mackie-Mason and Varian, or Sidek and Spulber.

groups and these groups cannot arbitrage between the services associated with different contract provisions. Each user accepts one contract and the firm associates a price with the use of that contracting provision. In no other respects do the services differ to the user except in price and, of course, how the user values the difference between the two contract provisions. These provisions will be called H and L, where H will be a more attractive provision than L (e.g., one will involve more hours of use per month). Let  $P(H, 1)$  and  $P(L, 1)$  be the prices which result from using instrument H and L, respectively, for an ISP who offers only one service. Let  $P(H, 2)$  and  $P(L, 2)$  be the prices from an *identical* ISP if they hypothetically offers both services. H and L will be defined more precisely below; in general, one expects  $P(H, 1) > P(L, 1)$  and  $P(H, 2) > P(L, 2)$ .

! **Statistical test 1, Propensity to use contract provisions:** The endogeneity of provisions to implement  $P(L,2)$  in practice suggests a test for price discrimination. If  $P(L, 2)$  arises due to the presence of market power, then it will be used more frequently in markets with low density of supply. This will be testable below since the density of supply of ISP services is largely a function of the density of population, i.e., market structure can be treated as exogenous. Hence, the correlation between the  $P(L,2)$  and density of supply is a test of whether price discrimination arises from the use of market power. The disproportionate use of instruments in some types of locations will be labeled "location sensitivity."

! **Statistical test 2, Price separation:** If the marginal cost of limited or unlimited service does not differ between those who offer both contracts and those who do not, then second-degree price discrimination in the presence of market power leads to  $P(H, 2) - P(L, 2) > P(H, 1) - P(L, 1)$ . That is, the difference between the access price will be higher from ISPs with market power who are charging both prices instead of charging only either one alone. This property is labeled "pricing separation." The intuition is well-known. It is unlikely that pricing separation would arise if a firm is a price taker. Define the separation difference as  $S(H, L) = \{P(H, 2) - P(L, 2)\} - \{P(H, 1) - P(L, 1)\}$ . This is greater than zero if separation is present.

! **Statistical test 3, Sensitivity of price separation:** Let there be a third instrument M, such that M is a closer substitute for H than L. For example, this might arise if L is a very low limitation on hours of use, M is medium limitation and H is higher still. Let  $P(M, 2)$  and  $P(L, 2)$

be the prices for the two services, respectively, from an ISP who offers only both services. Second degree price discrimination leads to  $S(H, M) > S(H, L)$ . This property is labeled "separation sensitivity." Again, the intuition is familiar. Closer substitutes exhibit comparatively stronger price separation than distant substitutes.

! **Practical considerations:** As with all empirical studies of price discrimination, the standard model does not readily translate into an empirical method because it is difficult to observe the *same ISP* at separate times or in distinct different locations. Hence, one can only compare pricing behavior across two different ISPs. This raises many challenging issues. Here four issues are paramount. First, as a practical matter it will be difficult to see why the marginal cost of H and L are the same for ISPs who offer only one service and those who offer both. If anything, there might be economies of scope between H and L at firms who offer both. Hence, the absence of pricing separation need not be definitive evidence of the absence of price discrimination; however, its presence is strong evidence.

Second, to implement any of these tests one must look across different ISPs. The actual test in practice must aggregate across different firms in different and similar locations in some way. There are trade-offs associated with any aggregation scheme and the prior empirical literature does not suggest that one particular method is superior to all others. Third, and related, the market environment is complex and changing, so ISPs are not alike, each growing their own complex business model in an uncertain environment. Aggregating across firms requires controlling for many other determinants of prices which differ across ISPs. Fourth, and most constraining, quantity or market share are not observed in this study. Hence, any test must rely only on what is observed about prices and ISP contracting.

In this paper I will estimate a pricing function where  $XB$  captures many determinants of price other than contract provisions. Specifically, for each ISP contract let the price on that contract equal  $P = XB + a_{H1}d(H,1) + a_{L1}d(L,1) + a_{H2}d(H,2) + a_{L2}d(L, 2)$ , where  $d(H,1)$ ,  $d(L,1)$  are dummies for whether the price comes from an ISP who offers only high quality service or only low quality service, respectively. Similarly,  $d(H,2)$  and  $d(L, 2)$  are dummies for ISPs who offer both. The empirical work will estimate  $a_{H1}$ ,  $a_{L1}$ ,  $a_{H2}$ , and  $a_{L2}$ , from which one can compute

estimates of  $S(H,L)$ .<sup>15</sup>

#### 4. 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.<sup>16</sup> This data includes all relevant detail offered by

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<sup>15</sup> It is also possible to develop tests in a specification where  $\log(P) = XB + a_{H1}d(H,1) + a_{L1}d(L,1) + a_{H2}d(H,2) + a_{L2}d(L,2)$ , where  $S(H,L) = \exp[\{P(H,2) - P(L,2)\} - \{P(H,1) - P(L,1)\}]$ . That is, testing for pricing separation tests the "ratio" of prices instead of their difference, as outlined above. However, this additional method does not yield different results below, so the simpler specification will be used.

<sup>16</sup> 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*.

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, 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.<sup>17</sup> 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. And, as noted, there also is overlap with Greenstein [2000c], which looked at similar data for the purpose of measuring the determinants of price levels and for the purpose of constructing price indices.

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).

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<sup>17</sup> Citation to the price index for the Canadian ISPs, Stranger (2000) and to Greenstein(2000).

For testing pricing separation, 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.

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. 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.<sup>18</sup>

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

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<sup>18</sup> 24.2% quote two price schedules, 9.9% quote three, 5.1% quote four and 2.0% quote five or more.

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 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.<sup>19</sup> 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

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<sup>19</sup> 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.

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. 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.<sup>20</sup> 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.

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<sup>20</sup> 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.

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). 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.<sup>21</sup>

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.<sup>22</sup> 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.<sup>23</sup> 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

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<sup>21</sup> 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.

<sup>22</sup> 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.

<sup>23</sup> 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.

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. = \$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 at *thelist*. By definition this date tells us about the

most recent date at which the ISP filled out the survey on *thelist*.<sup>24</sup> *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. At the least, it suggests that we must control for date of quote.<sup>25</sup>

## 5. Statistical tests for locational sensitivity

For testing the important 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, similar to the ISPs examined in Greenstein [2000b].<sup>26</sup> 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

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<sup>24</sup> 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.

<sup>25</sup> 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.

<sup>26</sup> 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.

223 ISP come from especially uncompetitive market conditions.<sup>27</sup> 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 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.<sup>28</sup> The strength of this comparison is that it avoids aggregating apples and oranges. Its weakness is that it does not use all the data, though doing so it difficult and yields no additional insight for these purposes (see Greenstein (2000c)). 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

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<sup>27</sup> 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.

<sup>28</sup> Not all 1497 ISPs quote unlimited prices, so not all firms in the location data set are included.

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 market power.

! **Hour limitations.** Table 4 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. Overall, this pattern is consistent with the use of limited contracts for purposes of price discriminating.

The use of limited contracting by large firms reinforces the point. 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.<sup>29</sup>

! **Length of commitment:** The information about contract length is mixed at best. Similar to the above, rows 4-6 present information about the 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, inconsistent with any explanation about their use arising from use of market power.

However, 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. By itself, this provides weak evidence that these provisions arise from the use of market power, but it is not especially compelling combined with the other finding on locational sensitivity.

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.

## 6. Measuring price separation

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

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<sup>29</sup> 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.

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.<sup>30</sup> 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.<sup>31</sup>

*A. Exogenous variable definitions*

The regression on prices will use many variables similar to those discussed above. A few more are added to account for additional factors. 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 separation coefficients:* **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.

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<sup>30</sup> 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.

<sup>31</sup> 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.

! *Sensitivity of pricing separation:* **Max10-100** measures variation in price separation over different levels of limitation. It 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.

! *Miscellaneous of service:* **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.<sup>32</sup> **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.<sup>33</sup> **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.

! *Other features of the ISPs:* Most of these try to measure the quality of service at an ISP. These are "controls." For more discussion, see Greenstein [2000c]. 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.<sup>34</sup>

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<sup>32</sup> 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.

<sup>33</sup> 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.

<sup>34</sup> 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.

**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.<sup>35</sup> 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.<sup>36</sup> **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.<sup>37</sup> 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.

### *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.<sup>38</sup> Hence, I show both estimates.

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<sup>35</sup> These formed the basis for **handholding** in Greenstein [2000], which also looked at an ISP's propensity to advertise capabilities toward unsophisticated users.

<sup>36</sup> 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.

<sup>37</sup> 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.

<sup>38</sup> 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

The first column uses the level of prices as the endogenous variable. The second column uses the log of prices as the endogenous variables.<sup>39</sup> 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 in this data set.<sup>40</sup> Hence, the two columns show only OLS estimates with the White correction for heteroscedasticity. 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.

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. First we describe the results, then analyze price separation in detail.

! *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 \$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

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Stranger (2000), in which there is strong evidence for using the log of price as the endogenous variable.

<sup>39</sup> At this time we found only one example of a "free" ISP. This observation was omitted.

<sup>40</sup> 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.

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. More on this below.

! *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. **Dateindicator** also 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. As with Greenstein (2000c) 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.

### *C. Evidence of price separation*

Using the estimates from the first column, Table 6 calculates price separation for various levels of hourly limitations and contract length. The estimates from the second column yield qualitatively similar results, so these are not presented. The first column of Table 6 presents the difference between unlimited and limited (lengthy) contracts for prices coming from ISPs with only one type of contract. The second column presents the difference between unlimited and limited (lengthy) contracts for prices coming from ISPs with both types of contracts. The last column computes the difference between the second and first columns, i.e., price separation or  $S(H, L)$ , as noted above.

The first result is that price separation arises with limited contracts, consistent with presence of market power. For all contract limitations the difference is large. For a 20 hour limitation the difference is \$3.81 cents. For a 50 hour limitation the difference is \$5.97. For limitations between 60 and 100 the difference is \$5.98. For limitations over 100 hours the difference is \$8.25. These are clearly large (note: include standard errors in future draft).

The latter two numbers are partly an artifact of the estimation. 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.

Albeit with this caveat, the differences the last column of Table 6 also display increasing price separation, consistent with separation sensitivity. That is, price separation increases as a limited price approaches unlimited service. Price is at its highest for the limited prices over 60 hours, where the unlimited and limited prices are closer substitutes. This arises largely from the varying estimates on **Max60-100** and **Maxabove100**.

The estimates for contract length offer little evidence of the presence of market power. There is little difference between the prices for those with only long contracts, only monthly contracts or both. The estimates of price separation have the wrong sign. As with the previous findings about contract length, these are inconsistent with the presence of market power.

Overall, there is plenty of evidence of price discrimination arising from market power in discounts for hourly limitations, in sorting users between different limitations, and in the influence of limited prices on unlimited prices. That said, it is worth noting that much of this behavior disproportionately arises in low density markets, an area describing 10-15% of the US population, depending on how one counts for it.

In contrast, lengthier contracts do not display any of the same features. It is much easier to conclude that these provisions are associated with defensive motives, i.e., reducing customer turnover to competitors and passing on the savings to users in the form of a discount. This is price discrimination in the sense of charging different prices to different groups, but it is not price discrimination that arises out of the use of market power.

## 7. Conclusion

This paper presented a discussion of two contracting provisions, hourly limitations and length of commitment. Both are consistent with cost-saving motives. All three statistical tests all suggest that hourly limitations arise from the use of market power, while contract length does not.

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, the difference is how 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.

These pricing patterns suggest nuances to the usual story, however. 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 have a distaste for such limitations and competitive pressures prevent ISPs from using them often. Only in less competitive settings can they do so.

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 issues 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.

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

	All prices	Limited	Unlimited	All prices Set up fee required
<b>Household</b>				
<b>Monthly</b>	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>
<b>Quarterly</b>	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>
<b>Six Months</b>	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>
<b>Yearly</b>	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>
<b>Business</b>				
<b>Monthly</b>	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>
<b>Quarterly</b>	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>
<b>Six Months</b>	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>
<b>Yearly</b>	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

HRS	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**

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

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

**Table 4**  
**Descriptive Statistics**

<b>Category</b>	<b>Variable</b>	<b>Mean</b>	<b>St. Dev.</b>
<b>Hourly Limitations</b>	<b>Lim5-10</b>	0.057	0.233
	<b>Lim11-20</b>	0.038	0.192
	<b>Lim21-30</b>	0.020	0.141
	<b>Lim31-40</b>	0.005	0.072
	<b>Lim41-50</b>	0.011	0.105
	<b>Lim51-60</b>	0.013	0.112
	<b>Lim61-100</b>	0.023	0.149
	<b>Lim100+</b>	0.043	0.203
<b>Length of Contract</b>	<b>Quarterly</b>	0.046	0.210
	<b>Halfannually</b>	0.049	0.216
	<b>Yearly</b>	0.118	0.322
<b>ISP Contracting Practices</b>	<b>Limitedonly</b>	0.064	0.245
	<b>Unlimitedonly</b>	0.648	0.478
	<b>Onlyshort</b>	0.648	0.478
	<b>Onlylong</b>	0.027	0.163
<b>Price Separation in Hourly Limitation</b>	<b>Maxl10-30</b>	0.065	0.247
	<b>Maxl40-60</b>	0.018	0.133
	<b>Maxl60-100</b>	0.008	0.088
	<b>Maxabove100</b>	0.012	0.108
<b>Price Separation in Contract Length</b>	<b>Billquarter</b>	0.036	0.187
	<b>Billhalf</b>	0.041	0.199
	<b>Billyear</b>	0.096	0.295
<b>Miscellaneous Influences on Prices</b>	<b>Setupfee</b>	0.189	0.392
	<b>Business</b>	0.066	0.247
	<b>Multi-email</b>	0.932	0.253
	<b>Slow28</b>	0.080	0.272
	<b>Fast56</b>	0.114	0.318
	<b>Dateindicator</b>	7.938	5.637
	<b>Furtherinfo</b>	0.044	0.205
<b>Engineering Capabilities of the ISP</b>	<b>Offersdedicated</b>	0.049	0.215
	<b>Frontier</b>	0.351	0.477
	<b>T-1backbone</b>	0.885	0.319
	<b>Offers ISDN</b>	0.661	0.473
<b>Other ISP Services Offered With the Standard Bundle</b>	<b>Complements</b>	0.296	0.457
	<b>Oldtechnology</b>	0.059	0.236
	<b>Real</b>	0.171	0.377
	<b>Games</b>	0.044	0.206
	<b>Chat</b>	0.052	0.223
	<b>Video</b>	0.022	0.145
	<b>Screening</b>	0.006	0.074
	<b>Scope1</b>	0.537	0.499
	<b>Scope2</b>	0.512	0.500
	<b>1areacode</b>	0.502	0.500
<b>2-5areacodes</b>	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	**
Maxl10-30	-0.230	0.590		0.000	0.026	
Maxl40-60	1.934	1.324		0.066	0.041	
Maxl60-100	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.

**Table 6**  
**Price separation estimates**

<b>Variable</b>	<b>A*</b>	<b>B*</b>	<b>S*</b>
<b>Lim5-10</b>	7.957	11.770	3.814
<b>Lim11-20</b>	5.910	9.723	3.814
<b>Lim21-30</b>	3.961	7.774	3.814
<b>Lim31-40</b>	1.507	7.485	5.977
<b>Lim41-50</b>	1.305	7.282	5.977
<b>Lim51-60</b>	2.819	8.797	5.977
<b>Lim61-100</b>	-1.435	4.548	5.983
<b>Lim100+</b>	-4.060	4.195	8.255
<b>Quarterly</b>	1.871	1.519	-0.351
<b>Halfannually</b>	3.548	2.680	-0.869
<b>Yearly</b>	4.878	3.867	-1.011

- A\* = The difference between the limited and unlimited price for ISPs with only limited prices or only unlimited prices.
- B\* = The difference between the estimated prices for ISPs with both limited and unlimited prices.
- S\* = The difference between B\* and A\*, the difference in price spread between firms who offer both and firms who offer one of each.