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7 *Internet-Related Services: The Results of Asymmetric Regulation*

Broadband services for residential customers and small businesses are currently provided by digital subscriber lines (DSL) using traditional incumbent local exchange carriers, by broadband using competitive local exchange carriers, and by cable modems using hybrid fiber-coaxial cable networks operated primarily by cable television operators. In a number of countries, incumbent local exchange carriers are required to share their networks with competitive local exchange carriers through unbundling rules at prices set by regulation. However, cable providers have not been required to share their networks. This is an example of asymmetric regulation, a regulatory approach that has created significant economic distortions and has helped cause the bankruptcy of a number of broadband competitive local exchange carriers.[1]

This chapter explores the implications of asymmetric regulation and asks if it serves the interests of consumers, comparing the experience of Korea, a country without such a regulatory regime, with that of the United States. It also examines the experience of the competitive local exchange carriers in providing these services and their subsequent financial distress.

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1. A digital subscriber line is an asymmetric line through which data moves downstream at significantly faster speeds than it moves upstream. See Charles Jackson, this volume.

In addition, it addresses the effects on investors of asymmetric regulation. I begin with an examination of the recent experience of various countries in securing broadband access for their businesses and consumers.

Broadband Internet Access across Countries

Korea has by far the largest penetration of high-speed, broadband, Internet access, on a per capita basis, of any country. Korea had 4.32 million broadband Internet connections in November 2000, with about 64 percent using digital subscriber lines and the other 36 percent using cable modems.[2] Korea had 9.2 broadband Internet connections for every 100 inhabitants in 2000, or a penetration equal to 9.2 percent of its population. Canada was next, with a 4.5 percent penetration, and the United States was third, with a 2.2 percent penetration. Surprisingly, U.S. penetration was less than one-fourth that of Korea. Thus the runner-up countries were far behind Korea. Some advanced economies had extremely low penetration rates, such as Germany at 0.2 percent and the United Kingdom at 0.09 percent (see figure 7-1).

Korea has no unbundling requirements like those of the United States and Canada (to allow competitive local exchange carriers to compete with incumbent local exchange carriers). However, the United Kingdom and Germany do require network unbundling.[3]

Of course, important demographic differences exist among the countries. In Korea a high proportion of people live in apartments, which increases population density and decreases the cost of providing a wired telecommunications network.[4] However, Hong Kong, which also has a high proportion of people living in apartments, had a penetration ratio of only 3.5 percent.[5] Also, the United States, Canada, Germany, and the United Kingdom are among the richest countries as measured by per capita gross domestic product or income. They also have high computer pene-

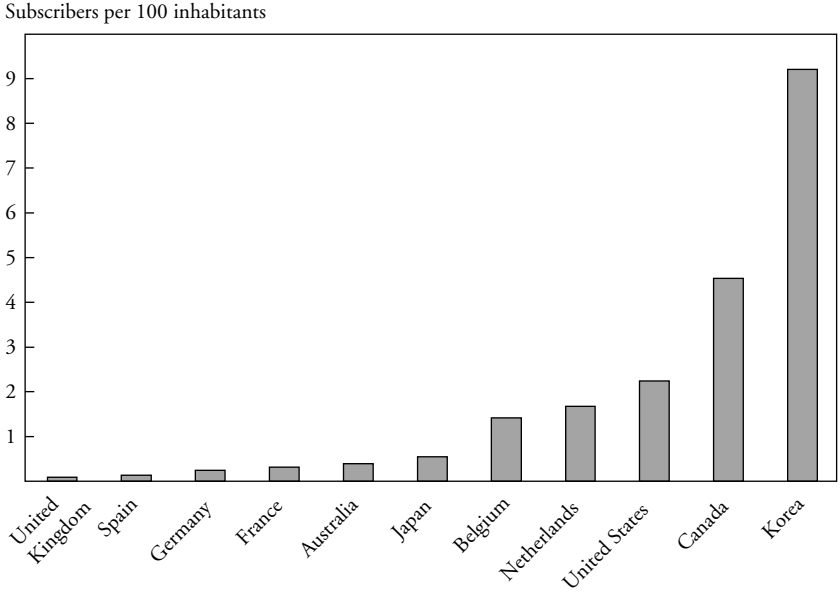
2. Organization for Economic Cooperation and Development database. At the end of June 2001 the number of subscribers had increased to 6.25 million subscribers. See Korean Ministry of Information and Communication: (http://www.mic.go.kr [June 2001]).

3. Both the United Kingdom and Germany have high levels of computer penetration and narrowband Internet access.

4. For further discussion see W. Blois, "Broadband in a Time of Financial Crisis," talk given at IDATE conference, November 2001 (www.IDATE.fr).

5. Hong Kong OFTA, "Hong Kong: Fact Sheet 2000, Telecommunications" (www.ofta.gov.hk/frameset/press_index_eng.html [August 2000]). Hong Kong requires regulatory network unbundling.

Figure 7-1. *Broadband Connections per 100 Inhabitants, Eleven Countries, 1999*



Source: OECD Telecommunications Database, 2001.

tration ratios, which should also increase demand for broadband Internet connections. Thus Korea being first in this area—and by a wide margin—is remarkable. An important factor may be that Korea does not have a regulatory requirement for network unbundling, as do the United States, the United Kingdom, and Germany.

An econometric investigation on penetration rates across countries for the years 2000 and 2001, using data on broadband penetration, the broadband access price, the narrowband access price, and gross domestic product per capita provides additional insights on the determinants of broadband penetration.[6] Included also is a variable for regulation, which equals 1.0 if the regulators require unbundling as in the United States, the United Kingdom, and Australia. Unfortunately, the sample is not especially large, with just twenty-six observations and even smaller subsamples for certain of the regressions. Overall, the findings are that broadband

6. I was unable to collect data on Internet subscriptions per capita. However, the use of gross domestic product per capita should control for this variable.

penetration depends significantly on gross domestic product per capita, with an elasticity of approximately 1.0.[7]

Neither the narrowband nor the broadband access prices are statistically significant, an outcome consistent with the fact that Korea, with by far the largest broadband penetration, had among the least expensive narrowband access prices and broadband prices higher than those in both Australia and Canada, which have significantly lower broadband penetration. (This comparison may no longer hold, as Korean broadband prices have since fallen.) The elasticity of broadband penetration with respect to broadband price is estimated at about –1.5 and is statistically significant at the 10 percent level. Another variable estimated to have an important (but not statistically significant) effect is regulation, which leads to a decrease in broadband penetration of approximately 70 percent. Thus per capita gross domestic product, broadband price, and regulation appear to have the largest effects on broadband penetration. However, given the small sample and the absence of strong statistical significance of the estimated coefficients, these results should be interpreted as suggestive, rather than as definitive.

Narrowband and Broadband Prices

It might be argued that narrowband (dial-up) Internet access is actually a close substitute for broadband access, so that focusing on broadband access alone is misleading.[8] Yet the two types of access and the services they support have important differences. Cable modems and digital subscriber lines offer access speeds about ten to thirty times higher than dial-up access. Many of the services supported by broadband connections are not available through narrowband connections. The demand for applications that can be supported only by high-bandwidth connections suggests that the product markets for narrowband and broadband access are distinct. A quantitative analysis of U.S. data supports this conclusion.[9]

Although the price of connection for broadband and narrowband access (when adding the price of a second line) may be similar, the quality-

7. This elasticity is estimated to be 1.16, the broadband access price is estimated to be –0.98, and the regulation variable is estimated to be –0.71. The R^2 of the regression is 0.32.

8. This section is taken largely from Hausman, Sidak, and Singer (2001b).

9. The estimated coefficient for narrowband access price has the incorrect sign in a number of the regression specifications.

adjusted price is not. In particular, a second line is not always "on," is subject to congestion, and cannot simultaneously support several broadband applications, such as streaming video and video conferencing. Second, many heavy Internet users who own a wireless telephone can avoid the cost of a second line.[10] If the choice to subscribe to wireless is made before the decision to obtain Internet access, as would seem likely for many Internet users, the monthly price of the wireless connection should not be included in the price of narrowband access. Third, if the price of a second telephone line should be included in the price comparison, then certainly the installation cost of a broadband connection (typically $150 for a cable modem) should be incorporated as well.[11] Under any reasonable comparison, the prices of broadband and narrowband access are different and hence support the notion of distinct product markets.

An additional indication that narrowband and broadband Internet access are in separate product markets arises from the "natural experiment" of individual states setting their own narrowband prices. The data demonstrate that prices of second telephone lines vary greatly across regulatory jurisdictions, while the price of broadband access remains relatively constant. These data support the hypothesis that narrowband access does not constrain the price of broadband access.[12]

The definition of the product market can also be established empirically. If it can be shown that narrowband prices (including the access charge plus the price of a second telephone line) do not constrain broadband prices, then a hypothetical monopoly provider of broadband access could more easily sustain a 5 percent price increase.[13] This would confirm the existence of a separate broadband market.

The econometric analysis is based on August 1999 price data from forty-one states and fifty-nine cable television multiple-system operators who were offering either @Home or Road Runner.[14] For cable subscribers, the broadband access price varied from $34.95 a month to $64.95 a

10. Many college students and singles with roommates reportedly use home telephone lines for their computer modems only and make voice calls on digital cellular telephones.

11. Some cable providers provide free or low-cost cable modems. Amortized over a thirty-six-month period, the results are not sensitive to whether the cable modem price is included.

12. Paul Rappoport, Donald Kridel, and Lester Taylor (this volume) also support the separate-market hypothesis.

13. This test is the approach to market definition commonly used by antitrust authorities in the United States, the European Union, and Australia. See Department of Justice (DOJ) (1992).

14. A partial resurvey was conducted in August 2001 to recheck the data, and similar conditions were found.

month.[15] The installation fee varied from $50 to $150, which was amortized over different periods for various regression specifications, depending on the predicted churn rate for broadband customers. The narrowband data were collected from the incumbent local exchange carriers providing service in the areas served by the local cable provider.[16] Prices for second telephone lines (used, for instance, by many America Online customers) varied from $7.70 to $47.62 a month.[17] Installation costs for a second telephone line varied from $16.90 to $55.30, a cost that was amortized over its expected service life.[18] The standard price for @Home cable service was $40 a month, but the price for narrowband access varied considerably because the monthly price of a second line varied, from $8 to $48.

These data indicate that, under the Department of Justice (DOJ) test for market definition, narrowband access is in a separate market from broadband access, because narrowband prices vary by a factor of over 300 percent, while broadband prices vary much less.[19] Thus variations in the price of narrowband access cannot explain the variations in the price of broadband access. Otherwise, one would expect to observe a decrease in the price for broadband access service when second telephone line rates are low, and vice versa. There is no significant relationship of this kind, a result that demonstrates the existence of separate product markets for antitrust purposes.[20] This conclusion is confirmed by a benchmark regression (see table 7-1).

The estimated coefficient for the narrowband access price is essentially zero (–.003) and far from statistically significant. Thus the hypothesis that the price of narrowband access does not affect the price of broadband

15. Prices for noncable subscribers are typically $10 a month higher. Consideration of these prices for customers who do not subscribe to cable had no significant effect on the results.

16. These data cover the price of monthly telephone access, not the price to the Internet service provider. Although @Home and Road Runner provide both services in their price, because many narrowband service providers provide national service at a single price, the price of Internet service was included in the intercept coefficient in the regression specification.

17. For residential customers who do not use a second (or higher) telephone line, the marginal price of access is zero (everywhere but in New York City) as long as a local network node exists. I use different weighted averages for use of first and second telephone lines in some of the regression specifications, but the results are not sensitive to the particular weights used.

18. The installation cost captures only the connection fee and does not reflect the costs of rewiring the telephone jack.

19. DOJ (1992). The standard price of broadband Internet access over cable has increased to $50 a month. The price of America Online has increased to $23.95 a month.

20. Some narrowband Internet customers do not use a second telephone line. The data using a weighted average of customers who use a first or second telephone line was analyzed. The results do not differ significantly.

Table 7-1. *Benchmark Regression of Broadband Internet Access Prices on Narrowband Internet Access Prices (estimated)*[a]

Log price of broadband access	*Coefficient*	*Standard error*	t-*statistic*
Intercept	4.03	.090	47.7
Log price of narrowband access	–0.003	.026	–0.102
Road Runner indicator	–0.116	.013	–8.64
Addendum			
Number of observations	59		
Standard error of regression	.011		
R^2	.572		

a. The price of a second telephone line is treated as predetermined in the regression specification because it is set by regulation, not by market forces. Also, a Hausman specification test (Hausman [1978]) does not reject exogeneity. Furthermore, regulation requires that tariffs of incumbent local exchange carriers be identical across a service area.

Broadband access price is the natural logarithm of cable broadband access price plus amortized monthly cost of installation. Narrowband access price is the natural logarithm of the price of a second telephone line plus second-line fees plus amortization of the installation cost.

access (transport) and Internet service is not rejected: Lower narrowband prices do not constrain the prices charged for broadband access. Because the price of America Online is not included in any explanatory variable, its effect is contained in the estimate of the intercept coefficient.

The findings are uniform across specifications corresponding to varying definitions and amortization periods for installation costs. The estimated coefficient of the narrowband price variable is always small and statistically insignificant. The Road Runner indicator variable, however, is about –11.6 percent and highly statistically significant, with a *t*-statistic of 8.6. Thus Road Runner is priced significantly below @Home, on average.

When the regression specification is expanded to include median household income, average population density, the cost of the calls from the residence to the Internet service provider, and age of the population, these variables are not statistically significant. Moreover, the coefficient of principal interest—the effect of narrowband access price—does not change in any meaningful way.[21] The coefficient of the estimated logarithm price of narrowband access is the same whether or not demographic variables are included.[22] The results of three additional regressions with different specifi-

21. The *p*-values for an *F* test are .105 and .235 for the two regression specifications. Both *p*-values are well above normal significance levels.

22. The *p*-values for an *F* test for the use of demographics is 0.63 for the first specification and 0.84 for the second specification. Neither *F* statistic is near the 0.05 significance level.

cations are presented in appendix 7A. All of these results confirm the conclusion that the price of narrowband access does not constrain the price of broadband access. Broadband Internet access is a separate product market.

Asymmetric Regulation

If the goal is to have actual competition that benefits consumers, the following questions must be addressed. Should network elements be unbundled so that competitive local exchange carriers can provide broadband Internet access using incumbent local exchange carriers' network elements? Should similar regulations exist for hybrid fiber-coaxial cable networks? Finally, is the current situation of asymmetric regulation appropriate? The following analysis demonstrates that if regulators require the entire local telephone network to be unbundled, as the Federal Communications Commission (FCC) has done in the United States, the likely outcome will be less competition.

The principal concern in this analysis is the effect of regulation on consumer welfare.[23] The appropriate goal is not a competitor welfare goal, as regulators often seem to believe, but a consumer welfare goal. The FCC regulates under a public interest rule, which should translate into a consumer welfare rule, but the FCC has used the public interest standard to provide it wide latitude in its decisions, often resulting in consumer harm in the billions and tens of billions of dollars a year.[24]

The Telecommunications Act of 1996 established the basic principles for the unbundling of network elements.[25] Sections 251 and 252 provide a framework for the pricing of interconnection, resale, and unbundling. Section 251(c)(3) requires any incumbent local exchange carrier (other than certain rural carriers) to offer competitors access to its network elements on an unbundled basis. In turn, Section 251(d)(2) requires that the FCC, when determining whether to mandate the unbundling of the local exchange carrier's network elements under Section 251(c)(3), consider whether "access to such network elements as are proprietary in nature is

23. See Hausman (1998); Hausman and Shelanski (1999); and Hausman and Sidak (1999). The Australian regulator, the ACCC, has explicitly established this goal for their approach to telecommunications regulation. The ACCC refers to the goal as the "long-term interests of end users."

24. See Hausman (1997, 1998); and Hausman and Shelanski (1999). See also Crandall and Waverman (1995).

25. See Hausman and Sidak (1999).

necessary" and whether "the failure to provide access to such network elements would impair the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer." Together, those two subsections are known as the "necessary" and "impair" requirements.

Consumer Welfare

The implementation of the necessary and impair requirements should be based on the goal of furthering overall competition not merely the economic interests of individual competitors. If overall competition is increased, consumer welfare and economic efficiency will also generally increase.

Consumers benefit from competition because it leads to greater innovation and lower prices. However, the FCC's public interest standard, although central to the interpretation of telecommunications regulations, has not always been aligned with consumers' interests. The primacy that economists ascribe to economic efficiency and to the maximization of consumer welfare has a related benefit: It harmonizes economic regulation and antitrust (competition) law. In 1996 Congress endorsed this view when it emphasized in the Telecommunications Act that the improvement of consumer welfare was the new legislation's overarching purpose.

Suppose that substitutes outside the incumbent local exchange carrier's network are available and are being offered by competing firms. The availability of the competing services occurs because some firms have made the rational economic decision that they can efficiently provide these services. Two conclusions follow from this situation. First, the element as provided by the incumbent carrier cannot be essential for competition because competition is already occurring without its provision by the carrier. Thus the network element cannot be labeled an essential facility, and its availability to competitors at regulated prices is not necessary for the development of competition. Nor would a decision not to mandate unbundling at a regulated price impair the competitive supply of telecommunications services. Second, competition will not be adversely affected if a competitive local exchange carrier cannot procure the unbundled element from the incumbent carrier. Other firms are providing substitutes outside that carrier's network, and so, in the absence of diminishing returns to scale, increased demand for the element can be met at the same or lower economic cost.

One approach to the necessary and impair standard within a consumer welfare framework is termed the Hausman-Sidak test.[26] The definitions of *necessary* and *impair* rely on the competitive analysis of demand and supply substitution that provides the primary basis for other areas of regulatory economics and, more particularly, the analytical basis for modern antitrust and competition law. The Hausman-Sidak test consists of the following five necessary elements for the FCC to mandate unbundling:

—It is technically feasible for the incumbent carrier to provide the competitive carrier unbundled access to the requested network element in the relevant geographic market.

—The incumbent carrier has denied the competitive carrier use of the network element at a regulated price.

—It is impractical and unreasonable for the competitive carrier to duplicate the requested network element through any alternative source of supply.

—The requested network element is controlled by an incumbent carrier that is a monopolist in the supply of a telecommunications service to end users and that employs the network element in question in the relevant geographic market.

—The incumbent carrier can exercise market power in the provision of telecommunications services to end users in the relevant geographic market by restricting access to the requested network element.

To implement the fifth element of the Hausman-Sidak test, one modifies the DOJ's test for unilateral market power only slightly, examining whether an incumbent carrier's refusal to sell a particular unbundled network element to a competitive carrier at a regulated price would impair competition. This part of the test is based on a critical-share analysis of the possibility of exercising unilateral market power.[27]

Intuitively, the impairment test asks whether the incumbent carrier can exercise market power when restricting access to a particular network element to the competitive carrier in a particular geographic market. If the carrier cannot exercise market power in the output market when declining to offer a particular network element at a total-element, long-run, incremental-cost price, all of the consumer benefits associated with a competitive outcome have already been secured, and the regulator should not order the network element in question to be unbundled. The Hausman-Sidak test is focused on protecting competition as opposed to competi-

26. Hausman and Sidak (1999).

27. The critical-share test is discussed in the appendix to chapter 6.

tors. If market forces can protect consumers from the harms of monopolization, then the regulators should not impose mandatory unbundling.

A network element should be unbundled only when the incumbent can exercise monopoly power in the absence of unbundling. When the incumbent has such power, competition is harmed by the denial of the unbundled element, and consumer welfare is decreased because consumers will pay a supracompetitive price for the final service (barring further regulatory distortions). This conclusion is closely related to the essential insight of the economic approach to regulation. Regulation should be used only in the situation of market failure—in this case, the exercise of unilateral monopoly power.

South Korea

Broadband Internet access is assumed to be a separate product market in Korea, as it is in the United States. The technology and economics of narrowband access in Korea are similar to those in the United States.[28] In Korea significant competition currently exists in the delivery of broadband access, even though Korea Telecom (its incumbent carrier) has not been required to provide unbundled elements to competitive carriers. Cable modem suppliers enjoy a similar freedom from mandated unbundling. Thus no open-access regulation or unbundling requirements have been implemented to date in Korea.

Hanaro Telecom, a competitive carrier, was the first provider of digital subscriber lines in Korea, connecting apartments to local stations via fiber-optic cable. In Korea about half of all households live in apartments; therefore, access to Korea Telecom's local loop is not indispensable in Hanaro's providing digital subscriber lines. In the case of the households not in apartments, Hanaro can provide broadband service through cable modems.

Cable infrastructure that is capable of broadband Internet service is owned mostly by the Korea Electric Power Corporation. However, although Korea Electric is the owner of the cable infrastructure, it does not provide cable television service or broadband Internet access. Cable service providers use the Korea Electric infrastructure to provide both cable television and broadband Internet cable modem service. Thrunet is the largest cable modem provider, but other operators also provide cable modem

28. The major difference is that telephone calls are charged for by the minute in Korea, so that unlimited local calling for a monthly fee does not exist as it does in the United States.

service. Although there is no regulation for open access, de facto open access exists for cable modem services because cable service providers offer open access using the common infrastructure of the Korea Electric network. Prices of cable modem service, and entry into the field by service providers, are not subject to government regulation. Table 7-2 illustrates the 2001 penetration of digital subscriber line and cable modem access. Digital subscriber lines account for 64 percent of Korea's broadband access subscribers (the reverse of the U.S. situation).[29]

When the Hausman-Sidak test is used to determine whether unbundling should be implemented in Korea to increase consumer welfare, the answer appears to be no:

—*It is technically feasible for the incumbent carrier to provide the competitive carrier unbundled access to the requested network element in the relevant geographic market.* Since Korea does not have regulation-mandated unbundling, this factor is not applicable.

—*It is impractical and unreasonable for the competitive carrier to duplicate the requested network element through any alternative source of supply*. Hanaro Telecom has provided broadband Internet access both by providing its own facilities and by using the cable network infrastructure of Korea Electric.

—*The requested network element is controlled by an incumbent carrier that is a monopolist in the supply of a telecommunications service to end users and that employs the network element in question in the relevant geographic market*. To the contrary, broadband Internet access is provided by seven additional providers, in addition to Korea Telecom.

—*The incumbent carrier can exercise market power in the provision of telecommunications services to end users in the relevant geographic market by restricting access to the requested network element*. The critical-share test demonstrates that Korea Telecom does not have unilateral market power in the provision of broadband Internet access.

The overall conclusion, based on a consumer welfare standard, is that the incumbent carrier should not be required to unbundle its network for competitive carriers to provide broadband Internet access. Competition in the market is substantial, output is high, and Korea Telecom cannot exercise unilateral market power. Thus no role for regulation to protect consumers is evident.

29. In 2000 cable modems accounted for 64.3 percent of U.S. broadband Internet subscribers in the FCC estimates. In the first quarter of 2001 cable modems accounted for about 70 percent of broadband access (*Telechoice*, June 25, 2001).

Table 7-2. *Broadband Internet Access, Korea, May 2001*

Type of broadband	*Millions of subscribers*	*Market share (percent)*
Digital subscriber lines		
Korea Telecom	2.4	46.8
Hanaro Telecom	0.75	14.6
Others	0.15	2.9
Total	3.3	64.3
Cable modems		
Thrunet	1.0	19.5
Hanaro Telecom	0.52	10.1
Others	0.31	6.0
Total	1.8	35.6
Total broadband	5.13	

Source: Korea Ministry of Information and Communication (www.mic.go.kr).

The United States

In most areas of the United States broadband Internet access is available over digital subscriber lines and is offered by two types of local exchange carrier: incumbent carriers, which use their own networks, and competitive carriers, which typically rent network elements from incumbent carriers at prices set by regulators below economic costs.[30] Broadband Internet access is also offered over cable hybrid fiber-coaxial cable networks, which pass over 95 percent of U.S. residences. Cable operators are essentially unregulated and are not required to share their networks with competing firms. Thus U.S. broadband access is subject to asymmetric regulation: Incumbent carriers are highly regulated and are required to share their networks, while cable operators are unregulated and not required to share their networks.

Cable operators have refused to permit competing broadband Internet access providers to use their networks. Moreover, the largest cable operators have signed exclusive contracts with Internet service providers that tie their high-speed broadband Internet access to the use of cable-owned Internet service providers. Thus if cable customers want to use a noncable-owner internet service provider, they must pay twice—once for Internet access and use of the cable-owned service and again for the independent service provider.

30. See Hausman (1997, 1999a, 1999b).

In the first quarter of 2001 about 6.9 million households in the United States subscribed to broadband Internet access. About 70 percent of subscribers used cable modems and 30 percent used digital subscriber lines. Of the digital-line customers, 84 percent were served by incumbent carriers, 15 percent by competitive carriers, and 1 percent by long-distance carriers.[31] Cable modems' recent growth rate has been approximately equal to the growth rate of digital subscriber lines, at about 23 percent a quarter.[32]

Currently, AT&T is the nation's largest cable multiple-system operator. AT&T also controlled Excite@Home, the largest provider of residential broadband service, with approximately 3.3 million subscribers in July 2001. Before declaring bankruptcy in 2001, Excite@Home had exclusive contract rights to provide residential broadband service over the cable facilities of its three principal equity holders—AT&T, Comcast Corporation, and Cox Communications—which collectively accounted for over 35 percent of the nation's cable subscribers.[33] AOL Time Warner is the second largest cable provider and has an exclusive contract with Road Runner, the second largest provider of broadband Internet service, with 1.1 million subscribers in November 2000.[34]

The application of the Hausman-Sidak test to the U.S. broadband market is summarized as follows:

—It is technically feasible for U.S. incumbent carriers to provide competitive carriers unbundled access to the requested network element in the geographic market. Also it is technically feasible for the cable operator to provide access to its hybrid fiber-coaxial cable network in the geographic market.

—Incumbent carriers have not denied competitive carriers use of the network element at a regulated price; however, unregulated cable operators have refused access to competing broadband access providers and to nonaffiliated multiple-system operators.

—It is impractical and unreasonable for competitive carriers to duplicate the requested network element, the customer loop, through any

31. *Telechoice,* August 10, 2001. Incumbent carriers have a much larger percentage of residential customers than small business customers; competitive carriers are in the reverse position.

32. *Telechoice* estimates that digital growth declined from 23 percent in the first quarter of 2001 to 14 percent in the second quarter.

33. Excite@Home declared chapter 11 bankruptcy. It cut off AT&T's customers and has now terminated operations.

34. As a settlement with the Federal Trade Commission to receive approval of Time Inc., America Online agreed to provide service to three nonaffiliated Internet service providers when it begins to offer broadband service over the Time cable networks.

alternative source of supply in certain geographical areas. However, in other geographical areas economic duplication is possible. For cable modems, in most areas of the United States it is impractical and unreasonable for a competitive Internet service provider to duplicate the hybrid fiber-coaxial cable network. In certain areas duplication is possible for both incumbent carriers and competitive carriers. RCN has constructed a competing fiber optic network on the East Coast and the West Coast in certain urban areas. However, RCN has curtailed its expansion because of financial stringencies.[35]

—The requested network element is not controlled by an incumbent carrier that monopolizes the supply of a telecommunications service to end users and that employs the network element in question in the relevant geographic market. In most geographic markets the incumbent carrier is not a monopolist in the provision of broadband Internet access. Instead, the incumbent carrier competes with the cable operator's hybrid fiber-coaxial cable network, over which broadband Internet access is provided. Indeed, in July 2001 about 70 percent of broadband customers purchased broadband Internet access over cable networks and about 30 percent purchased such access using digital subscriber lines over incumbent carrier networks. Similarly, in most geographic markets cable modems have a competitor in digital subscriber lines.

—Incumbent carriers cannot exercise market power in the provision of telecommunications services to end users in the relevant geographic market by restricting access to the requested network element. These carriers could not exercise unilateral market power because sufficient marginal customers would shift to competing cable modem providers to make the attempted price increase unprofitable. The critical-share test (see appendix 6A) demonstrates that the incumbent carrier does not have unilateral market power in the provision of broadband Internet access. Whether the cable modem operator has unilateral market power is discussed below.[36]

The relatively slow deployment of digital subscriber lines has limited the incumbent carrier's ability to discipline any price increase by cable-based providers of broadband Internet access. Digital subscriber line deployment is constrained by technical impediments, because it is sensitive to the distance that transmissions must travel between the home and the

35. RCN had about 985,000 customers as of April 2001.

36. Cable companies sometimes claim that incumbents have market power for the supply of T1 lines. However, these carriers do not typically provide residential broadband service with T1 lines. Further, neither cable companies nor typically competitive carriers buy T1 connections from incumbents.

central office. These lines do not work (or work well) if the copper segment of the customer's line exceeds approximately three miles, which encompasses about 25–35 percent of incumbent carrier customers. Also, digital subscriber lines cannot be provided on a telephone that uses digital loop technology, which includes a large part of the southern United States, without substantial investment in electronics at remote terminals.

Even if digital-subscriber line providers were to overcome these technological limitations, significant regulatory barriers prevent them from competing effectively against cable broadband providers. The regional Bell operating companies, which are the primary providers of digital subscriber lines, operate within an entirely different regulatory environment than their cable competitors. First, they are excluded entirely from the core backbone market because of their exclusion from inter-LATA (local area transport and access) services under section 271 of the Telecommunications Act. These companies also face separate subsidiary requirements, which may make it more expensive to provide Internet search engines or content of any kind, and the Telecommunications Act requires the Bell companies to unbundle their network. The FCC has even indicated its intent to extend unbundling requirements to broadband Internet services, which decreases the economic incentives to provide these services.[37] Finally, the Bells' retail broadband rates are often regulated; cable modem rates are not. This asymmetric regulation prevents digital subscriber lines from being an effective competitor in the broadband Internet access market for residential customers.[38]

Thus under current regulation multiple-system cable operators are able to exercise unilateral market power, a conclusion consistent with the cable operators' ability to tie their broadband Internet access to customers. In the absence of such market power one would expect a sufficient proportion of marginal cable-modem customers to shift to digital subscriber lines and to force cable operators to provide customer choice for a nonaffiliated Internet service provider. The ability of cable operators to require these customers to "pay twice" demonstrates their market power.

A further difference exists between incumbent local exchange carriers and multiple-system cable operators: Incumbents do not provide content (the material downloaded by subscribers), so they do not have an economic incentive to distort competition for content. Cable operators provide con-

37. See Hausman (1997).

38. Satellites will not provide significant constraining competition to cable providers for broadband Internet access in the next few years. According to the FCC, as of December 31, 2000, satellites provided about 1.6 percent of high-speed Internet connections.

tent (video programming) both over the cable channels that they own and over their affiliated cable systems. Indeed, cable operators exercise significant monopoly power.[39] Internet video streaming competes—and will compete even more in the future—with video programming offered by cable systems. Cable system broadband Internet providers currently place significant restrictions on Internet video streaming to limit its use.

Competition among Content Providers

Full-service broadband providers integrate four services, or inputs:[40]

—Broadband content (for example, streaming video and audio, movies, video conferencing, interactive games.

—The aggregation of broadband content and complementary services (for example, chat rooms, instant messaging) by a broadband portal.

—Connectivity to the Internet supplied by a broadband Internet service provider.

—High-speed transport from the home to the Internet service provided by a cable operator, telephone company, or other broadband conduit provider.

A vertically integrated firm, offering both broadband transport and portal services, could profitably pursue two anticompetitive strategies. First, an integrated provider could engage in *conduit discrimination,* insulating its own conduit from competition by limiting its distribution of affiliated content and services over rival platforms. Conduit discrimination could involve a range of anticompetitive strategies, from refusing to distribute an affiliated portal over competing conduits to making popular content available only to customers using an affiliated conduit. Second, an integrated provider could engage in *content discrimination,* insulating its own affiliated content from competition by blocking or degrading the quality of outside content. Content discrimination could involve a range of strategies, from blocking outside content entirely to affording affiliated content preferential caching treatment.

Both of these strategies are potentially costly, but the benefits could outweigh the costs in certain situations. For example, a firm engaging in

39. The most straightforward evidence of this market power is that when RCN entered the cable market to compete with multiple-system operators, prices typically decreased by 10–20 percent. Cable operators moved premium channels into the basic tier, so that customers no longer paid extra for the premium channels.

40. This section has previously appeared in Hausman, Sidak, and Singer (2001a).

conduit discrimination will forgo revenues from content distribution over rival platforms. However, there are potentially countervailing benefits, because with conduit discrimination, customers will perceive the cable conduit as more valuable. This, in turn, will increase the demand for cable transport relative to other forms of transport. Hence a cable broadband provider will engage in conduit (or content) discrimination if the gain from additional access revenues from broadband users offsets the loss in content revenues from narrower distribution. To the extent that cable transport providers compete against digital subscriber line services and other broadband transport providers, the reduction in revenues from lost customers will be greater.

There are several ways in which a vertically integrated broadband provider can discriminate against unaffiliated content providers. First, it can give preference to an affiliated content provider by caching its content locally. Such preferential treatment ensures that affiliated content can be delivered at faster speeds than unaffiliated content. Second, a vertically integrated broadband provider can limit the duration of streaming videos of broadcast quality to such an extent that they can never compete against cable programming. For example, a vertically integrated firm like AT&T can block any competing content that it wants to (AT&T and other cable providers currently limit video streaming to less than ten minutes). Third, a vertically integrated firm such as AT&T and AOL Time Warner could impose proprietary standards that would render unaffiliated content useless. The academic literature on standards and network externalities provides theoretical and empirical support for the conjecture that AT&T could impose proprietary standards that would raise the switching costs for its subscribers and stifle competition in vertically related software markets.

AT&T's (and previously TCI's) traditional cable strategy has been to use its market power in the delivery of programming to expand its control over the programming itself. Time Warner used a similar strategy to limit competition in programming.[41]

Is Asymmetric Regulation Appropriate?

The current asymmetric regulation framework—requiring incumbent local exchange carriers to sell their network elements to competitive local exchange carriers at below-cost prices while cable modem operators are not

41. For example, see Shapiro and Varian (1999).

regulated—has no reasonable economic basis. This conclusion flows from the Hausman-Sidak test and from evidence that demonstrates that cable modem operators have the economic incentive and the ability to exercise unilateral market power and to discriminate against competitive content providers. In most geographic markets, one might conclude that no regulation is necessary since digital subscriber lines and cable modems compete against each other. However, the preferred outcome is to require both incumbent carriers and cable modem operators to provide access to their networks (without unbundling) where technically feasible. Prices would be determined by commercial negotiation between the parties.

Regulated Prices for Unbundled Elements: The FCC Approach

The legislative framework for incumbent carrier network unbundling was established in the 1996 Telecommunications Act. The FCC has since instituted numerous regulatory rules to implement the act, the most important of which is the Local Competition and Interconnection Order of August 1996.[42] The FCC, however, has established the basis for setting the prices of unbundled elements incorrectly, leading to less competition rather than to the desired increased competition.[43]

One way to analyze the problem of setting appropriate regulated prices for unbundled elements is to examine a new investment by an incumbent carrier. Suppose a competitor wants to buy the unbundled elements associated with such an investment. The carrier could offer the competitor a contract for the economic life of the investment—say ten to twenty years for investment in the local loop. The price of the unbundled element would be the total investment cost plus the operating costs each year for

42. FCC, "First Report and Order, CC docket No. 96-98 and 95-185," August 1, 1996. The FCC is being challenged by the incumbent local exchange carriers in federal court. The U.S. Supreme Court reversed and remanded for further consideration the FCC's regulatory approach in January 1999. See *AT&T Corp.* v. *Iowa Utils. Bd.,* 119 S. Ct. 721 (1999). In July 2000 the 8th Circuit Court of Appeals invalidated the FCC approach of basing its cost estimates on a hypothetical network rather than on the actual network in use. See *Iowa Utils. Bd.* v. *FCC,* 96-3321 (2000). The Court decision requires the FCC to modify its approach to cost estimation. The Supreme Court in 2002 reversed the Circuit Court of Appeals and upheld total-element, long-run, incremental cost. Further legal proceedings are likely.

43. For further discussion, see Hausman (1997, 1999a, 1999b).

the unbundled element. If demand did not materialize or prices fell, the new entrant would bear the economic risk of this outcome.[44]

However, regulation by the concept of total element, long-run, incremental cost as applied by the FCC typically allows the new entrant to buy the use of the unbundled element on a month-by-month basis. Thus if demand does not materialize or if prices fall, the incumbent carrier bears the risk. This carrier is required by regulation to give a free option to the new entrant to lease the use of the unbundled elements. The new entrant, however, is under no obligation to purchase or to continue purchasing the elements. So the monthly price of the unbundled element should be significantly higher than the total element, long-run, incremental cost so as to reflect the risk inherent in the sunk investments—or equivalently the value of the option.

Under the 1996 act the FCC mandated forward-looking, cost-based prices for competitors to use unbundled local exchange carrier facilities. The FCC does not permit any markup over cost to allow for the risk associated with investment in sunk assets; instead, it uses a total-element, long-run incremental cost approach, which is supposed to allow for recovery of the cost of investment and the variable costs of providing the service over the economic lifetime of the investment. However, this approach makes no allowance for uncertainty or the sunk and irreversible nature of telecommunications investment. The FCC assumed a "perfect contestability" market, in which no sunk costs exist. The perfect contestability standard is not the appropriate model to determine correct economic incentives for efficient investment when technological and economic uncertainty exist.

The concept of total-element, long-run, incremental cost assumes that all capital invested now will be used over the entire economic life of the new investment and that prices for the capital goods or the service being offered will not decrease over time.[45] With changing demand, changing prices, or changing technology, these assumptions are not necessarily true. Incremental cost assumes a world of certainty, whereas the actual world is one of uncertainty. Significant economic effects can arise from the uncertainty and the effects that the sunk nature of investment has on the calculation.

44. The contract (or regulation) could allow the new entrant to sell the use of the unbundled element to another firm if it decided to exit the business.

45. In contracts between unregulated telecommunications companies, such as long-distance carriers and their customers, significant discounts are given for multiyear contracts. This discussion follows Hausman (1997, 1999a, 1999b). For the options approach to investment in telecommunications, see Alleman and Noam (1999). See also Laffont and Tirole (2000).

Total-element, long-run, incremental cost calculations make the following assumptions:

—The investment is always used at full capacity.

—The demand curve does not shift inward (or outward) over time.

—A new or improved technology does not appear that leads to lower cost of production.

Of course, these conditions are unlikely to be valid over the life of the sunk investment. Thus uncertainty needs to be added to the calculation because of the sunk nature of the investment.[46]

Given the fundamental uncertainty and the sunk nature of the investment, a "reward for waiting" occurs because, over time, some uncertainty is resolved. The uncertainty can arise from at least four factors: demand uncertainty, price uncertainty, technological progress (input price) uncertainty, and interest rate uncertainty.[47] The fundamental decision rule for investment becomes

$$P^s > \frac{\beta_1}{\beta_1 - 1}(\delta + \lambda)I = m(\delta + \lambda)I,$$

where P^s is the output price net of operating costs, δ is the exponential depreciation rate, and $\lambda = r + \alpha$ is the sum of the risk-adjusted interest rate and the expected change in the price of output. The extra term that arises from sunk costs is the markup term $m = \beta_1 / (\beta_1 - 1) > 1$, since $\beta_1 > 1$. The term $(\delta + \lambda)I$ is the usual term in an investment rule that takes account of discounting and expected price changes (economic depreciation). The parameter β_1 takes into account the sunk-cost nature of the investment coupled with inherent economic uncertainty.[48] Parameter m is the markup

46. See Alleman (1999).

47. The FCC incorrectly assumes that taking account of expected price changes in capital goods and economic depreciation is sufficient to estimate the effect of changing technology and demand conditions. Thus the FCC implicitly assumes that the variances of the stochastic processes that determine the uncertainty are zero, that is, that no uncertainty exists. Under the FCC approach the values of all traded options should be zero (contrary to stock market fact), since the expected price change of the underlying stock does not enter the option value formula. It is the uncertainty related to the stochastic process as well as the time to expiration that gives value to the option, as all option pricing formulas demonstrate (for example, the Black-Scholes formula).

48. This equation is the solution to a differential equation. For a derivation see Dixit and Pindyck (1994). The parameter β_1 depends on the expected risk-adjusted discount rate, r, expected exponential economic depreciation, δ, the net expected price, α, and the amount of uncertainty in the underlying stochastic process. Note that this result holds under imperfect competition and other types of market structure—not just under monopoly, as some critics have claimed incorrectly. See Dixit and

factor required to account for the effect of uncertain economic factors on the cost of sunk and irreversible investments. Note that the markup factor equals unity, $m = 1$, for fixed, but not sunk, investments because such investments can be moved easily to other uses. Thus this equation

$$\frac{P^S}{m} > (\delta + \lambda)I,$$

which demonstrates that the value of the investment is discounted by the factor m to account for the sunk costs, compared to the fixed (but not sunk) cost case of $m = 1$. Investments that result in sunk costs must have higher threshold present values than investments that result in fixed but not sunk costs.[49]

Using the appropriate parameters for various components of incumbent carrier networks, accounting for the decrease in capital prices due to technological progress, and allowing for the expected negative change in (real) prices of most telecommunications services given the decreasing capital prices, the value of m is around 3.2 to 3.4. Thus a markup factor must be applied to the investment cost component of total-element, long-run, incremental cost, to account for the interaction of uncertainty with sunk and irreversible costs of investment. Depending on the ratio of sunk costs to fixed and variable costs, the overall markup on the incremental cost will vary, but the markup will be significant given the importance of sunk costs in most telecommunications investments.

When the markup for sunk and irreversible investment is applied, it should be used only for assets that are sunk, that is, potentially stranded. Investments that are fixed but not sunk would not have the markup. Applying this methodology to transport links and ports, which are treated as unbundled elements by U.S. regulation and whose proportion of sunk costs is 0.59, results in a markup factor for the overall investment of approximately 2.35 times the total-element, long-run, incremental cost. This estimated markup would be close to the appropriate markup for the regulated price of unbundled elements for digital subscriber lines, which mainly compose the loop from the central office to the customer premise. Thus FCC regulation has set the regulated price for unbundled loops at less than half the economically correct price when the sunk-cost nature of

Pindyck (1994, chapter 8). Imperfect competition is the expected competitive outcome in telecommunications because of its significant fixed and common costs.

49. See Hausman (1997, 1999a, 1999b).

loop investment is taken into account.[50] Failure by the FCC to set correct regulated prices has led to economically inefficient investment incentives in local broadband infrastructure in the United States.[51]

By contrast, the proportion of sunk costs for ports is about 0.10, so that the markup factor becomes 1.23 times the long-run incremental cost. The markup over this cost that takes account of sunk costs and uncertainty is the value of the free option that regulators force incumbent providers to grant to new entrants; for example, 1.35 times that cost for links and 0.23 times that cost for ports. This calculation demonstrates that the proportion of sunk costs has an important effect on the correct value of regulated prices.

Regulatory Failure: The Demise of U.S. Broadband Competitive Carriers

Soon after passage of the 1996 Telecommunications Act and the implementation of the FCC regulations on network unbundling, a number of competitive local exchange carriers began operations to provide digital subscriber line broadband Internet access. These carriers typically did not build network infrastructure to any significant degree. Instead, they used the incumbent local exchange carriers' loops, for which they paid prices based on the total-element, long-run, incremental cost.

At their peak, each of the three largest carriers—Covad, Northpoint, and Rhythms—had a market valuation in excess of 1 billion dollars.[52] All three have now filed for chapter 11 bankruptcy.[53] The carriers had ready access to capital markets until 2001, when financing became more difficult due to the deterioration of the profitability of telecommunications markets and the increasingly large cash-flow losses of each of the companies. A major reason for these companies' failure against the background of rapid overall market growth is FCC regulation, which caused the carriers to engage in a wasteful business strategy.

50. When considering this result, one should realize that a new copper loop investment over its fifteen-to-twenty-year expected economic lifetime will likely compete with wireless 3G networks offering speeds of two megabits a second. These 3G networks are beginning to be implemented. Indeed, the next generation of wireless, 4G, is being developed with planned speeds of ten megabits a second.

51. This is an outcome of government regulation, as FCC Chairman Michael Powell recognized in 2001. See Michael K. Powell, "Digital Broadband Migration," pt. 2, October 23, 2001 (www.fcc.gov).

52. Crandall and Hausman (2000).

53. HarvardNet, a large regional provider, also filed for bankruptcy; it ceased offering digital subscriber lines in late 2000.

To provide digital subscriber lines, each company faced a "rent or buy" decision. Did it make more economic sense to rent the unbundled elements from the incumbent carrier or to buy (invest) in network infrastructure? Because the FCC set the price of renting unbundled elements well below the economic cost of the elements, the answer was to rent. Essentially, the companies were exercising their free options, provided to them by the regulators.

Given the lack of required investment, the economic incentive for these companies was to expand as fast as possible. But none of them had a sustainable competitive advantage, because they were "playing with the house money"—the free options granted to them by the FCC. They spent large sums of money on marketing, but customer churn remained high because none of the companies had a superior product to sell. Indeed, the quality of the service was determined primarily by the quality of the loops, many of which were quite old, since copper loops are rarely replaced except when service interruptions occur. Similarly, the incumbent carriers did not have an economic incentive to invest in improving the quality of their loops, since the FCC had set prices for their loops well below the correct economic level.

The equity values of the three companies—Covad, Northpoint, and Rhythms—plummeted, and capital markets became closed to them. The result was bankruptcy. Faulty regulation led to a large expenditure of money with little remaining in terms of real assets.[54] Neither consumers, who had significant service disruptions when the competitive exchange carriers ceased operations, nor investors, who have little or nothing remaining from their investments, benefited from FCC regulation.[55] The results of the FCC's asymmetric regulation policy must be considered a failure, with an economic waste of billions of dollars.

Conclusion

Korea is number one by a wide margin in broadband Internet access. It is notable that Korea has not required regulatory network unbundling or

54. This outcome is different from the outcome in long-haul markets, where new providers constructed fiber-optic networks. A number of these long-haul providers have experienced financial difficulty, but their networks continue to be used, so that real assets remain from the investment. To the contrary, when Northpoint ceased operations, AT&T did not acquire any of its network assets. A similar outcome occurred for Rhythms.

55. Of course, investors are supposed to be able to look after their own interests, without the need of FCC regulation.

regulated prices. Broadband Internet access is a separate product market from narrowband access (in which the incumbent carrier is dominant). Only when a firm can exercise unilateral market power is regulated network unbundling necessary. Korea does not satisfy the conditions of the Hausman-Sidak test for deciding when regulated network unbundling should occur. Thus regulated network unbundling should not be required in Korea.

In the United States it is not clear that the conditions for regulated network unbundling are satisfied, since digital subscriber lines provided by incumbent carriers compete with cable modem service. Indeed, cable modems have a significantly larger customer share than digital subscriber lines. Given cable operators' superior technology (for now) and their demonstrated ability to distort competition, the current asymmetric regulation—in which incumbents carriers are regulated but cable operators are not—does not make economic sense. Both incumbents and cable operators should provide access to their networks. However, the price for access should be unregulated and should be established by commercial negotiation.

The correct regulatory rules for setting regulated prices of unbundled elements requires an allowance for the role of sunk costs. Yet regulators have ignored the effect of sunk and irreversible investments when using total element, long-run, incremental cost to set these prices. As a result, prices are then set below correct economic levels, and a free option is given to competitive carriers.

The result of this mistake in regulation has been to distort the broadband access market and, in particular, the provision of digital subscriber lines. Competitive carriers did not benefit from the policy. To the contrary, the largest three broadband carriers have gone into bankruptcy, with two of the three ceasing operations. Misguided regulatory policy has led to the waste of billions of dollars of investors' funds. This outcome is hardly a victory for regulation and the goals set by Congress when it enacted the Telecommunications Act of 1996.

Appendix 7A. Alternative Specifications of Regression of Broadband Access Prices on Narrowband Access Prices

Table 7A-1. *Specification 2. Left-Hand-Side Variable: Log of Excite@Home Access Price plus Amortized Monthly Cost of Installation (estimated)*

Variable	*Coefficient*	*Standard error*	t-*statistic*
Intercept	3.98	.107	37.2
Log price of narrowband access[a]	0.012	.031	0.382
Addendum			
Number of observations	43		
Standard error of regression	.002		
R^2	.004		

a. Narrowband access price is the log of the price of a second telephone line plus second-line fees plus amortization of installation cost.

Table 7A-2. *Specification 3. Left-Hand-Side Variable: Log of Cable Broadband Access Price plus Amortized Monthly Cost of Installation (estimated)*

Variable	*Coefficient*	*Standard error*	t-*statistic*
Intercept	4.86	0.564	8.62
Log price of narrowband access[a]	–0.029	0.033	–0.877
Log population density	0.001	0.010	0.057
Log median household income	–0.028	0.064	–0.433
Percent population age 65 and older	–0.006	0.006	–1.16
Percent population age 35 to 54	–0.009	0.009	–0.979
Percent population under age 5	–0.016	0.022	–0.757
Road Runner indicator	–0.114	0.014	–8.07
Addendum			
Number of observations	59		
Standard error of regression	0.002		
R^2	0.600		

a. Narrowband access price is the log of the price of a second telephone line plus second-line fees plus amortization of installation cost.

Table 7A-3. *Specification 4. Left-Hand-Side Variable: Log of Excite@Home Access Price plus Amortized Monthly Cost of Installation (estimated)*

Variable	*Coefficient*	*Standard error*	t-*statistic*
Intercept	4.81	0.653	7.36
Log price of narrowband access[a]	–0.0003	0.041	–0.007
Log population density	0.006	0.012	0.506
Log median household income	–0.077	0.083	–0.929
Percent population age 65 and older	–0.001	0.007	–0.157
Percent population age 35 to 54	–0.001	0.011	–0.112
Percent population under age 5	0.002	0.028	0.110
Addendum			
Number of observations	43		
Standard error of regression	0.002		
R^2	0.056		

a. Narrowband access price is the log of the price of a second telephone line plus second-line fees plus amortization of installation cost.

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