DRAFT

A New Measure of Residential Broadband Availability

Jed Kolko*
Public Policy Institute of California
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ABSTRACT

The only comprehensive published indicator of residential broadband availability in the US is number of providers in each zip code, as reported by the Federal Communications Commission (FCC). This measure has been widely used in academic and policy research to assess availability and to identify under-served areas, but it is acknowledged to be flawed and is often misinterpreted.

This paper develops an alternative measure of residential broadband availability. Using the December 2005 FCC data and individual broadband adoption data from Forrester Research, the paper estimates a relationship between the number of providers in a zip code and the level of residential broadband availability in the zip code.

Broadband availability is estimated to be 53% in zip codes with 1-3 providers, rising to 100% in zip codes with 14 or more providers. Aggregating these estimates at the national level implies that broadband was available to 86% of households in December 2005. Availability was highest in southern and western metropolitan areas like Miami and San Jose. Using these estimates of availability, population density and average income both have positive and highly statistically significant effects on broadband supply.

The results provide a user-friendly tool to help policymakers assess broadband availability. The estimates are also useful for future research about the effects of broadband availability.

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* Thank you to Forrester Research for permission to use Technographics Benchmark data. Contact author at kolko@ppic.org.

It is still unknown how widely available broadband is in the United States. Broadband providers do not make public maps showing their infrastructure or service availability, and regulators, with some local exceptions, have not required them to. The Federal Communications Commission (FCC) publishes data on where broadband subscribers are that is misleading when interpreted as an availability measure, but policymakers and researchers have used these FCC data to understand availability in the absence of alternative data. Despite the lack of knowledge about broadband availability in the US, some policymakers have justified initiatives to raise broadband adoption in part by claiming broadband availability lags in many areas, and others have argued against public initiatives to raise broadband adoption by arguing that broadband deployment in the US is essentially complete.

This paper presents a new measure of broadband availability. It re-interprets the FCC data to generate estimates of broadband availability at the national, state, and metropolitan levels. In essence, the paper estimates a relationship between the number of providers in a zip code, as reported by the FCC, and the extent of residential broadband availability in the zip code. The results are useful for understanding the current state of the broadband digital divide and for understanding what drives broadband deployment. With these results, future research projects can more accurately investigate the effects of raising broadband availability.

DESCRIPTION AND LIMITATIONS OF FCC BROADBAND DATA

The Federal Communications Commission requires all high-speed Internet providers to report subscriber information semi-annually.[1] High-speed Internet includes telephone-line-based DSL, cable modems, wireless, satellite, power-line, and other technologies that transmit data at 200 kilobits per second (kbps) or faster in at least one direction. Subscribers include both residences and businesses, though residential service dominates: of 50 million lines in service at the end of 2005, 43 million were residential and 7 million were businesses (FCC 2006). Prior to 2005, providers with fewer than 250 high-speed lines in a state were not required to report on subscriptions in that state. Therefore, the data for 2005 onward are more complete but are not comparable to earlier years' data.[2] The FCC publishes summary information on high-speed lines by technology, by state, by type of provider, and by type of end-user.

Most useful for understanding the geographic diffusion of broadband services, the FCC publishes semiannually the number of providers with at least one high-speed Internet subscriber in each zip code. Zip codes with one, two, or three providers offering service are grouped together and listed as having 1-3 providers; for all other provider counts, including 0, the exact number of providers is listed.[3] By this measure, broadband service is nearly ubiquitous in the U.S. Ninety-nine percent of zip codes have at least one provider, and 99.96% of households live in a zip code with at least one provider. Half of households live in a zip code with more than 10 providers, and the maximum number of

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[1] Providers that are not facilities-based – that is, that do not own or lease facilities that extend to the subscriber's location – are exempt from this requirement. See FCC (2006) for more detail.
[2] These reports are referred to as the Form 477 data collection program. The FCC publishes a semiannual high-speed services status update, available at www.fcc.gov/wcb/stats.
[3] The zip code provider counts for December 2005 are available at http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/hzip1205.pdf. Data are typically released with a seven- or eight-month lag.

providers in any zip code is 25. These provider data form the basis of the FCC's claim that "advanced telecommunications capacity is indeed being deployed on a reasonable and timely basis to all Americans" (FCC 2004).[4]

Many argue that the FCC's Form 477 data are insufficient for understanding the market for high-speed Internet services. The General Accounting Office (GAO) lists several concerns. First, the FCC data reflects geographic patterns in subscriptions, not availability. Provider counts, therefore, could understate availability in areas where service is available but no one subscribes. This situation describes satellite broadband, which is available to nearly every household with a clear view of the southern sky but accounts for a very small share of high-speed subscriptions.[5] Second, many zip codes cover large geographic areas, and providers with a subscriber in a zip code might not offer service throughout the zip code. This could overstate broadband availability if the FCC data are interpreted to mean that an entire zip code is served by a provider. Third, the FCC data include providers who serve only businesses, which could overstate the level of availability if the data are interpreted to mean availability for residential customers. Fourth, providers reporting service include those that buy or lease telecommunications facilities from wholesalers who might themselves offer retail service as well. Thus, the provider counts might reflect the level of market competition better than the extent of physical infrastructure if that infrastructure is shared among multiple providers (GAO 2006).

[4] Congress charged the FCC with "encouraging the deployment of advanced telecommunications capability to all Americans" in Section 706 of the 1996 Telecommunications Act.

[5] Satellite accounts for less than 1% of all high-speed lines (FCC 2006). Because satellite offers slower speeds for higher monthly fees and requires costlier hardware, satellite is not considered an adequate substitute for the main wireline broadband technologies, cable and DSL, and satellite subscriptions might be more prevalent where cable and DSL are unavailable.

The FCC zip code provider counts, therefore, are hard to interpret. They are, at best, an imperfect measure of some combination of the deployment of wireline infrastructure, the extent of residential availability, and the depth of market competition. Many at the FCC acknowledge these shortcomings: in the FCC's 2007 Broadband Deployment Notice of Inquiry, three of the five FCC commissioners refer specifically in their statements to the need for improved data.[6] Furthermore, the published FCC zip code data include no information on the price or speed of service, which would be essential for understanding geographic differences in broadband markets within the U.S.[7] Nonetheless, "there is no practical alternative to using the FCC data in assessing broadband availability" (Flamm 2006). Policymakers use the FCC data to describe the broadband landscape, and although some reports are careful to mention that the FCC data do not reflect whether broadband is available to every residence in a zip code, the data are nonetheless used as a measure of broadband deployment.[8] Academic researchers have also relied on FCC data, and their approaches are described in the following section.

ACADEMIC RESEARCH ON BROADBAND AVAILABILITY

Most academic research on broadband supply relies on the FCC data in order to draw conclusions about the availability of or competition in broadband services. An ideal measure of broadband availability would indicate whether broadband is available at the household level, or, in a geographic area, the percentage of households where broadband

[6] Notice of Inquiry, FCC 07-21, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-21A1.pdf. FCC Chairman Martin and Commissioners Copps and Adelstein noted the need for better data, the latter two vociferously so.

[7] Data on price and speed are also essential for understanding international differences in broadband services. Ultra-high-speed fiber service, for instance, is far more prevalent in Korea and Japan than in the U.S., as reported by the Organisation for Economic Co-operation and Development, www.oecd.org/sti/ict/broadband.

[8] See, for instance, California Public Utilities Commission (2006).

is available. In the absence of these ideal measures, researchers interpret the FCC provider count data as either a binary measure or a linear measure.

The binary approach classifies zip codes into those with no providers offering service and those with at least one provider offering service. Zip codes with at least one provider offering service are treated similarly regardless of the number of providers offering service in the zip code. Prieger (2003) and Flamm (2006) take this approach: both papers look at regressions of broadband availability on zip-code level characteristics, where broadband availability is a binary variable that equals one if there is at least one provider offering service in the zip code.[9]

The linear approach uses the number of providers as the outcome variable to be explained. Grubesic and Murray (2004) follow a similar regression framework as Prieger (2003) and Flamm (2006), using the provider count as a continuous dependent variable with zip-code level characteristics as independent variables, and Grubesic (2006) uses provider count and spatial autocorrelation analysis to group zip codes into regions and to describe their patterns of broadband supply. Both papers using this linear approach are careful to refer to local broadband "competition," not just "availability," since it is unclear whether differences in provider counts reflect differences in availability, especially at higher provider counts. Still, these papers do not attempt to express the effects of additional providers on quantities (i.e., broadband adoption levels) or prices (i.e., of broadband subscriptions), so the provider count variable is unsatisfying as a linear dependent variable because its relationship to market outcomes is unclear.

[9] Prieger (2003) uses the FCC data from June 2000, with most zip code characteristics from the 1990 Census. A key finding is that zip code median income has no statistically significant effect on broadband availability. Flamm (2006) uses the FCC data from December 2005. His results are preliminary but are notable for considering a wide range of zip code characteristics, including exogenous geographic variables like terrain.

The General Accounting Office (GAO, 2006) report on broadband takes both the binary and linear approaches to using FCC data. In its analysis of deployment, GAO, like Prieger (2003) and Flamm (2006), regresses a binary variable for broadband availability on zip code characteristics. However, GAO has access to the confidential raw FCC provider data and is therefore able to develop a more accurate estimate of whether broadband is available at the addresses of a sample of 1,500 households.[10] The binary measure that GAO derived is therefore a better reflection of broadband availability at the residential address, and GAO estimates broadband is available to 91% of households in their sample. Separately, in its analysis of adoption, GAO regresses household-level broadband adoption on household characteristics and the number of providers, again using the more accurate estimate of providers derived from FCC data. GAO finds no statistically significant effect of the number of providers on adoption, conditioning the regression on there being at least one provider.[11]

Two recent papers examine broadband supply without using FCC data. Whitacre and Mills (2007) use individual broadband adoption data from the Current Population Survey (CPS) and county- and city-level data on broadband infrastructure capacity, but the limited geographic information in the CPS allows them to match infrastructure measures to individual records at only a highly aggregated level: the urban and rural

[10] At each address in the sample, the GAO started with the publicly available FCC count of broadband providers with subscribers in that zip code, and then excluded: (1) providers with only satellite broadband subscribers in that zip code, (2) providers offering broadband only to businesses in that zip code, (3) DSL providers if the address is beyond 2.5 miles from a telephone company central office, (4) cable providers if the household reported that cable service does not pass the residence, as well as others. See GAO (2006), p. 51.

[11] As Flamm (2006) points out, the interpretation of the second part of GAO's (2006) analysis is unclear. GAO estimates neither a reduced-form model (which would require replacing the number of providers, which is endogenous, with exogenous supply-shifters) nor a demand model (which would require prices). Nonetheless, the model GAO estimates does point out that the number of providers offering service at an address, if measured accurately, is uncorrelated with adoption. A key difference between GAO (2006) and the current paper is that the current paper uses the public FCC data, which cannot be corrected using the methods GAO used.

portion of each state. They find no effect of DSL infrastructure on broadband adoption and, more puzzling, a statistically significant negative effect of cable infrastructure on broadband adoption, and conclude that infrastructure differences do not help explain the rural-urban gap in broadband adoption. Kolko (2007) uses household broadband adoption data from Forrester Research, a technology consultancy; because Forrester reports zip code, these data can be matched to zip code characteristics that could affect broadband supply. By regressing adoption on zip code density and median income (supply-shifters) and household demographics (demand-shifters), Kolko (2007) concludes that both income and density have a positive and statistically significant effect on broadband supply. This result contradicts Whitacre and Mills (2007), who find no relationship between density and broadband supply, and is more convincing because it relies on disaggregated zip-code level supply measures rather than the state rural-urban cells.[12] The Whitacre and Mills (2007) and Kolko (2007) papers demonstrate that broadband supply can be analyzed in a reduced-form model without using the FCC data. However, neither of these papers presents an estimate of the level of broadband availability or of geographic differences in availability.

METHOD

The goal of this paper is to generate a mapping between the number of broadband providers in a zip code and the level of residential broadband availability in that zip code. The empirical strategy is to recover the relationship between provider counts and broadband availability by merging the FCC zip code provider count data with household

[12] There are roughly 30,000 residential zip codes in the US. There are, in contrast, a maximum of 102 state urban-rural cells (2 per state plus DC).

data from Forrester Research. Each year Forrester conducts its Technographics benchmark survey of 60,000-100,000 households about their technology adoption and behaviors.[13] Because Forrester reports the zip code of respondents, the FCC zip code provider count can be merged with household broadband adoption and demographic information.

Broadband adoption is higher in zip codes with more broadband providers. The unadjusted means of broadband adoption – without controlling for household characteristics – rises from 20% in zip codes with 1-3 providers to over 30% in zip codes with 7 providers to 40% in zip codes with 10 providers to over 50% in zip codes with 18 providers, as shown in column 1 of Table 3. Broadband adoption increases steadily with provider count, except at the extremes where sample sizes are very small: in zip codes with no providers, broadband adoption is 41%, and in zip codes with 25 providers – the most reported by the FCC – broadband adoption is 33%.[14]

Households in zip codes with higher provider counts could have higher demand for broadband since broadband providers are more likely to serve areas where they predict demand to be higher. To isolate the extent to which the zip code provider counts reflect differences in broadband supply rather than broadband demand, the empirical strategy is to control for household demographics that are assumed to affect demand for broadband using the model:

[13] Forrester's Technographics surveys are conducted by mail in English; the samples are selected from national market research panels to be representative of US households demographically and are weighted to correct for differences in response rates. Forrester has used TNS/NFO's market research panel since 2001 and used NPD's panel in earlier years. Forrester collects data in the 48 contiguous states and the District of Columbia, but not in Alaska or Hawaii.

[14] The means for zip codes with provider counts of 0, 23, 24, and 25 are all based on samples of 25 or fewer respondents, so the means are estimated with large standard errors. (Table 2 shows the number of households in Forrester's dataset in each type of zip code.) It is surprising that the mean broadband adoption in zip codes with no providers is not zero. Of the 25 respondents, 9 reported having broadband over DSL, and 1 reported having broadband over cable modem.

$$broadband_i = \alpha + \sum_{k=0}^{25} \beta_k FCC_{jk} + \lambda individualchar_i + \varepsilon_i$$

FCC_{jk} is a dummy that equals 1 if the number of broadband providers in zip code j equals k, and 0 for all other values of k. K takes values from 0 to 25, representing the range of the number of providers the FCC reported for zip codes.[15] Estimating the model yields values for β_k that describe how broadband adoption varies by zip-code provider count, holding household demographics constant.[16] The model is estimated using a probit regression, with standard errors corrected by clustering on zip code, and then predicted values of broadband adoption are generated for every level of FCC provider counts at the mean of the household demographic variables.[17] Intuitively, the predicted values reflect the likelihood of broadband adoption in zip codes with different provider counts for a household with average demographics.[18]

It is important to stress that the FCC provider count measure is not an exogenous measure of broadband supply, and the model being estimated is neither a reduced-form model nor a demand model. The number of providers offering service in a zip code is the result of exogenous factors on both the demand side and the supply side. Therefore, the results of this model estimation cannot be used to predict how broadband adoption in a

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[15] Since the FCC combines providers counts 1-3 into a single category, K takes on 24, not 26, values. Because one category is dropped to prevent co-linearity, the model includes 23 dummy variables for FCC provider counts.

[16] The demographic variables include dummies for age, income, education, racial, ethnic, and household structure categories, as well as attitudinal statements about technology.

[17] The procedure using the application Stata was to estimate the model using the *probit* command and then predict values with the *adjust* command using the *by* option with the FCC provider count variable. The *adjust* command returns average predicted values and the lower and upper bounds of the 95% confidence interval.

[18] This model is similar to the reduced-form model of household broadband adoption in Kolko (2007), in which broadband adoption is a function of factors assumed to affect demand, such as household income, age, and family size, and factors assumed to affect supply, such as population density and zip code median income. The model in the current paper replaces the factors affecting supply with the FCC provider count dummies.

zip code would change if the number of broadband providers in the zip code changed, due for instance to a local initiative to provide city-wide Wi-Fi (wireless broadband) service.

Predicted broadband adoption increases with the provider count.[19] The predicted values for broadband adoption, holding household characteristics constant, for zip codes with different provider counts, are presented in column 2 of Table 3 and shown graphically in Figure 1. For the representative household with average demographics, broadband adoption is predicted to rise from 22% in zip codes with 1-3 providers to more than 40% in zip codes with 14 or more providers, as shown in column 2 of Table 3. The differences in predicted adoption in zip codes with different provider counts are statistically significant for much of the provider count distribution. The upper bound of the 95% confidence interval (CI) for predicted adoption in zip codes with 1-3 providers is .242, which is above the lower bound of the CI for 4 providers but below the lower bound of the CI for 5 providers. Using a similar test, the difference in predicted adoption is statistically significant for counts of 4 and 6; for counts of 5 and 7; for counts of 6 and 8; and so on. At higher provider counts, the differences are not statistically significant: the upper bound of the CI for 14 providers, for instance, is above the lower bound for all higher provider counts. For this reason, the model was re-estimated with provider counts 14 and higher grouped into one category, and the resulting set of predicted adoption levels are presented in column 5 of Table 3.

[19] Households in zip codes with higher provider counts indeed have higher demand for broadband, as evidenced by predicted broadband being higher than actual broadband adoption in areas with provider counts of 4 and lower, and by predicted broadband being lower than actual broadband in areas with provider counts of 5 and higher.

The goal of this method is to derive an estimate of broadband availability. Availability is estimated for each provider count by comparing the predicted adoption level for the representative household with the predicted adoption level for the top category, provider count 14 and above. The key assumptions are that (1) broadband availability is 100% in zip codes with the highest predicted adoption, and (2) differences in predicted adoption for a representative household in areas with different provider counts are due entirely to differences in availability. Given the widespread availability of broadband in most of the US today, the assumption of 100% availability in zip codes where 26% of the population lives does not seem farfetched,[20] though if availability is less than 100% in these zip codes then the implied availability measure for all zip codes will overstate actual availability. The assumption that differences in predicted broadband adoption, holding household demographics constant, is due to availability, is discussed in a companion paper (Kolko 2007), which shows that underlying supply-side factors are consistent with technical and economic features of broadband. However, if the differences in predicted broadband adoption are not due entirely to availability differences, then the implied availability measure would understate actual availability.

Dividing predicted broadband adoption for each provider count by .420 – the predicted broadband adoption in zip codes with at least 14 provides – yields the implied broadband availability measure, shown in column 6 of Table 3. In zip codes with 1-3 providers, the implied availability is 53%: slightly over half of households in these zip codes are estimated to be able to get broadband. Implied availability reaches 76% at 7 providers and 90% at 10 providers. Although the implied availability measures could overstate or understate actual availability, depending on how well the underlying

[20] Column 3 of Table 1 shows that 74% of the population lives in zip codes with 13 or fewer providers.

assumptions hold, they provide a compelling alternative to the binary and linear interpretations of the FCC data.

APPLICATIONS AND CONCLUSION

Mapping FCC provider counts into a measure of implied residential broadband availability makes it possible to answer two important policy questions. First, how widely available is broadband today at the metropolitan, state, and national level? Second, what factors predict broadband availability? Previous policy and academic research has used the FCC data to answer these questions using the binary interpretation of these data, but the answers change considerably when using the implied availability measure.

To estimate broadband availability at the national, state, or metropolitan level, the procedure is to take the average implied availability across all zip codes in the area, weighted by the number of households in each zip code. Zip codes that cross a metropolitan area boundary or, less commonly, a state boundary are apportioned according to the share of households.[21]

Following this method, implied broadband availability in December 2005 is 86% nationally. This is considerably below the binary interpretation of the FCC measure, which suggests that essentially all households live in a zip code where broadband is available. Implied broadband availability varies across states, ranging from 94% in the District of Columbia to 65% in Alaska (see Table 4). Kentucky is a useful point of comparison because the ConnectKentucky initiative has gathered confidential provider data to estimate broadband availability. ConnectKentucky estimated that 77% of

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[21] The correspondence between zip codes and metropolitan areas (2006 CBSA definitions) and states was generated using the Mable/Geocorr engine, http://mcdc2.missouri.edu/websas/geocorr2k.html.

households in the state could get broadband as of June 2005, which is close to the 73% implied availability measure for Kentucky derived using this method.[22]

Among the largest metropolitan areas, implied broadband availability is above the national average for all but two areas. Implied availability is highest in Miami, San Jose, and Phoenix, where it exceeds 97%. In general, southern and western metropolitan areas have higher implied availability than eastern and Midwestern areas do. Comparing availability by state or metropolitan area is difficult using a binary interpretation of the FCC provider counts: because only 1% of zip codes have no providers, many states and metropolitan areas have no zip codes with no providers, making availability appear complete and equal across those states and areas.[23]

The second application of the implied availability measure is to re-assess factors that predict availability. Other research has looked at determinants of availability using a binary availability measure as the dependent variable, sometimes finding plausible factors, like average zip code income, to have no significant effect on availability. As the above analysis shows, however, a binary availability measure obscures considerable variation in broadband availability by grouping areas where availability might be as low as 53% (the implied availability measure for in areas with 1-3 providers) with areas where availability is at or near 100%. Using the binary availability measure as a dependent variable is particularly problematic since a very small percentage of zip codes, containing an even smaller percentage of the population, still has no broadband providers.

Using the implied availability measure as a dependent variable, zip code density and zip code income have statistically significant and large effects on availability. Table

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[22] As cited in GAO (2006), p. 17.

[23] Flamm (2006) ends up omitting numerous states from his analysis because he includes state fixed effects in explaining zip code level availability and therefore has no within-state variation for many states.

6 presents results from a regression comparing the binary availability measure and the implied availability measure.[24] Two independent variables are included: zip code household density and zip code median household income, both in log form.[25] Using the binary availability measure, household density and median income have positive and statistically significant effects (column 1 of Table 6), though the t-value for median income is only 2. Using the implied availability measure, though, both variables have much larger magnitude and a higher level of statistical significance than when using the binary availability measure. Using the binary measure provides little variation in the dependent variable, making it harder to assess the factors affecting broadband supply.

A thorough investigation of the factors affecting the supply of broadband would include a longer list of independent variables. However, the purpose of this section is to compare results using the different availability measures, not to provide a thorough analysis of the exogenous factors affecting broadband supply, and this short list of independent variables is sufficient to make the point. Previous work that has tried to explain broadband supply using a binary availability measure is likely to have understated the extent of geographic variation in supply and understated the effect that factors like income or density have on broadband availability.

Unfortunately, this method cannot be used to track changes in availability over time. The FCC changed its reporting procedures in 2005, so earlier data on provider counts aren't comparable. Furthermore, the mapping of provider counts to implied availability depends on the assumption that availability reaches 100% for some number of providers; this assumption is less plausible in earlier years when broadband availability

[24] The binary dependent variable specification most closely resembles Prieger (2003) and Flamm (2006) but with far fewer explanatory variables here.
[25] Zip code population, area, and median income come from the 2000 Census.

was less widespread. And the relationship between provider count and availability could change over time as regulatory or other factors affect competition: for instance, large-scale consolidation of providers could reduce the number of providers everywhere without changing the share of households where broadband is available.

Still, for looking at broadband availability at a point in time, this method improves upon other attempts to use FCC data, yielding estimates of broadband availability at the national and sub-national levels. In turn, these estimates give a clear picture of geographic differences in broadband availability and can be used to analyze factors affecting supply and, in future research, to assess the effect of broadband availability on social and economic outcomes.

Table 1: Broadband Providers by Zip Code, December 2005 (FCC)

# of providers with a subscriber in zip code	# of zip codes	% of zip codes, cumulative	% of zip codes, weighted by households, cumulative*
0	298	0.99	0.04
1-3	9,710	33.25	4.86
4	4,076	46.80	9.36
5	3,104	57.11	14.67
6	2,358	64.94	20.40
7	1,715	70.64	26.67
8	1,392	75.27	33.59
9	1,207	79.28	41.10
10	1,168	83.16	49.48
11	1,022	86.55	57.86
12	894	89.52	65.84
13	800	92.18	73.63
14	661	94.38	80.63
15	534	96.15	86.59
16	437	97.60	91.68
17	284	98.55	94.96
18	186	99.17	97.05
19	119	99.56	98.40
20	60	99.76	99.11
21	38	99.89	99.59
22	20	99.95	99.80
23	3	99.96	99.84
24	7	99.99	99.93
25	4	100	100

* author's calculation using household counts from 2000 Census

Table 2: Forrester Sample Sizes, by Zip Code Provider Count

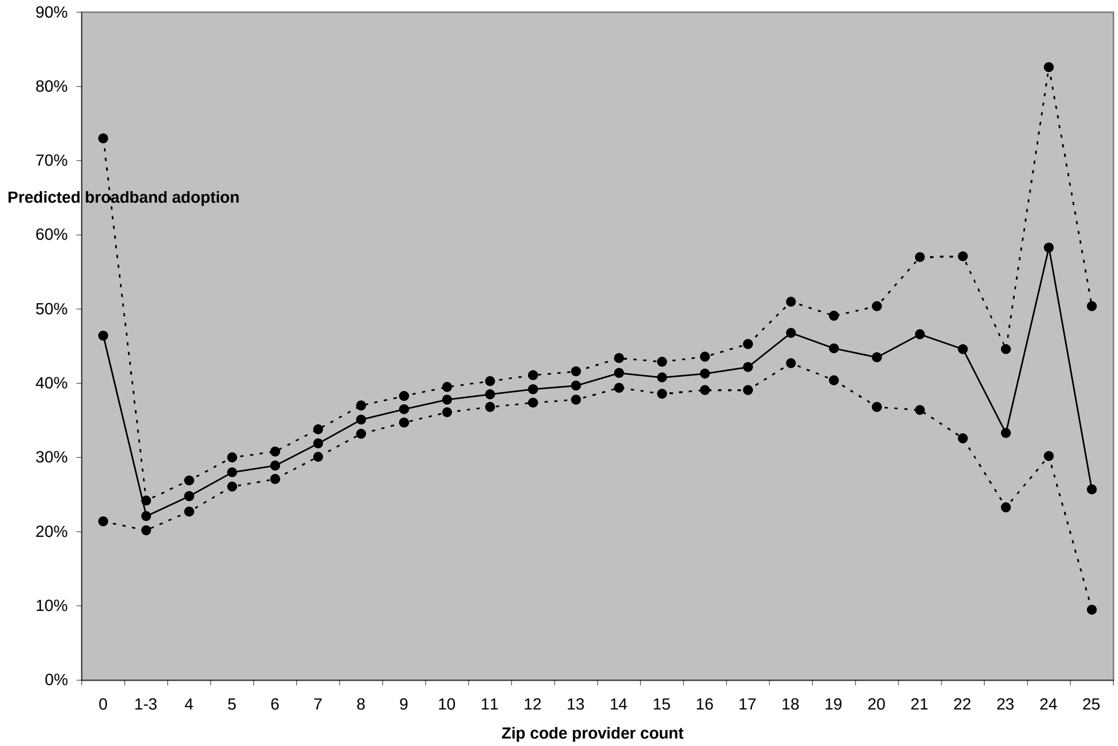
# of providers with a subscriber in zip code	Sample size (unweighted)	% of sample
0	25	0.04
1-3	3,149	5.25
4	2,902	4.84
5	3,553	5.93
6	3,967	6.62
7	3,936	6.57
8	4,426	7.39
9	4,870	8.13
10	5,339	8.91
11	5,025	8.39
12	4,616	7.70
13	4,391	7.33
14	3,828	6.39
15	3,200	5.34
16	2,731	4.56
17	1,643	2.74
18	983	1.64
19	685	1.14
20	294	0.49
21	196	0.33
22	112	0.19
23	18	0.03
24	19	0.03
25	18	0.03

Table 3: Predicted Broadband Availability, by Zip Code

	(1)	(2)	(3)	(4)	(5)	(6)
Zip code provider count	Actual broadband adoption	Predicted broadband adoption*	Predicted broadband adoption*	Predicted broadband adoption*	Predicted broadband adoption*	Implied broadband availability**
		Point estimate	Lower bound, CI	Upper bound, CI	Point estimate, 14+ collapsed	
0	.408	.464	.214	.730	.465	***
1-3	.200	.221	.202	.242	.222	53%
4	.236	.248	.227	.269	.248	59%
5	.283	.280	.261	.300	.280	67%
6	.294	.289	.271	.308	.290	69%
7	.334	.319	.301	.338	.319	76%
8	.363	.351	.332	.370	.351	83%
9	.369	.365	.347	.383	.365	87%
10	.401	.378	.361	.395	.378	90%
11	.418	.385	.368	.403	.385	92%
12	.433	.392	.374	.411	.392	93%
13	.447	.397	.378	.416	.397	94%
14	.474	.414	.394	.434	.420	100%
15	.475	.408	.386	.429		100%
16	.482	.413	.391	.436		100%
17	.486	.422	.391	.453		100%
18	.546	.468	.427	.510		100%
19	.544	.447	.404	.491		100%
20	.554	.435	.368	.504		100%
21	.591	.466	.364	.570		100%
22	.537	.446	.326	.571		100%
23	.471	.333	.233	.446		100%
24	.712	.583	.302	.826		100%
25	.325	.257	.095	.504		100%
missing		.348	.312	.386		

* based on probit estimation of broadband adoption, holding demographics constant
** based on the assumption that availability = 100% at 14+ providers
*** assumed to be 0% in subsequent calculations

Figure 1: Predicted Broadband Adoption by Zip Provider Count



Note: solid line represents predicted values, and dotted lines represent upper and lower bounds of 95% confidence interval. Data from columns 2-4 in Table 3.

Table 4: Implied Broadband Availability, by State

State	Implied availability
District of Columbia	93.7%
Florida	93.4%
Arizona	92.6%
California	91.8%
Maryland	90.8%
Colorado	90.2%
Utah	89.8%
Nevada	89.5%
New Jersey	89.4%
New York	88.4%
Illinois	88.3%
Connecticut	88.3%
Washington	88.1%
Oregon	88.1%
Georgia	87.9%
Texas	87.5%
Pennsylvania	86.8%
Rhode Island	86.7%
Virginia	86.7%
North Carolina	86.4%
Ohio	85.7%
Michigan	85.2%
Tennessee	84.8%
Massachusetts	84.4%
New Mexico	84.3%
Louisiana	84.2%
New Hampshire	84.0%
Minnesota	83.3%
Kansas	83.2%
South Carolina	83.1%
Indiana	82.3%
Missouri	81.4%
Delaware	80.3%
Wisconsin	79.7%
Idaho	78.5%
Alabama	78.4%
Mississippi	78.2%
Oklahoma	78.0%
Vermont	75.8%
Montana	75.3%
Nebraska	74.1%
Arkansas	73.8%
Wyoming	73.8%
Kentucky	73.5%
South Dakota	72.0%
Iowa	71.3%
North Dakota	70.0%
Maine	69.7%
West Virginia	69.3%
Hawaii	66.0%
Alaska	65.2%

Table 5: Implied Broadband Availability by Metropolitan Area

State	Implied availability
Miami-Fort Lauderdale-Miami Beach, FL	98.2%
San Jose-Sunnyvale-Santa Clara, CA	98.0%
Phoenix-Mesa-Scottsdale, AZ	97.5%
Denver-Aurora, CO	96.9%
San Francisco-Oakland-Fremont, CA	96.3%
Atlanta-Sandy Springs-Marietta, GA	96.2%
Los Angeles-Long Beach-Santa Ana, CA	95.5%
Orlando-Kissimmee, FL	95.3%
New Orleans-Metairie-Kenner, LA	95.3%
Chicago-Naperville-Joliet, IL-IN-WI	94.9%
Tampa-St. Petersburg-Clearwater, FL	94.8%
San Diego-Carlsbad-San Marcos, CA	94.7%
Seattle-Tacoma-Bellevue, WA	93.6%
Portland-Vancouver-Beaverton, OR-WA	93.6%
Dallas-Fort Worth-Arlington, TX	93.5%
Baltimore-Towson, MD	93.3%
Columbus, OH	93.3%
Las Vegas-Paradise, NV	93.2%
New York-Northern New Jersey-Long Island, NY-NJ-PA	92.6%
Washington-Arlington-Alexandria, DC-VA-MD-WV	92.5%
Indianapolis-Carmel, IN	92.4%
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	92.1%
Minneapolis-St. Paul-Bloomington, MN-WI	91.9%
Nashville-Davidson--Murfreesboro, TN	91.9%
Houston-Sugar Land-Baytown, TX	91.8%
Sacramento--Arden-Arcade--Roseville, CA	91.4%
Charlotte-Gastonia-Concord, NC-SC	91.4%
Detroit-Warren-Livonia, MI	91.3%
Richmond, VA	91.1%
Cleveland-Elyria-Mentor, OH	90.8%
Virginia Beach-Norfolk-Newport News, VA-NC	90.5%
Kansas City, MO-KS	89.4%
Boston-Cambridge-Quincy, MA-NH	89.3%
San Antonio, TX	89.1%
Pittsburgh, PA	89.1%
Austin-Round Rock, TX	88.8%
Buffalo-Niagara Falls, NY	88.5%
Riverside-San Bernardino-Ontario, CA	87.7%
St. Louis, MO-IL	86.7%
Milwaukee-Waukesha-West Allis, WI	86.6%
Providence-New Bedford-Fall River, RI-MA	86.4%
Louisville-Jefferson County, KY-IN	82.5%
Cincinnati-Middletown, OH-KY-IN	80.7%

Note: includes all metropolitan areas (2006 definition) with at least 500,000 households (2000 Census)

Table 6: Factors Affecting Broadband Availability

	Dependent variable: Binary FCC measure (estimate and standard error)	Dependent variable: Predicted availability (estimate and standard error)	Summary statistics (mean and SD)
Log household density (x 100)	.027 (.005)	4.28 (.030)	5.81 (2.03)
Log median income (x 100)	.067 (.033)	7.91 (.184)	10.63 (.34)
R-squared	.001	.461	
N	28809	28809	

Notes:

- regressions using OLS (coefficients at means very similar for probit model of binary measure
- weighted by number of households in the zip code
- "Predicted availability" using the measures from last column of table 3

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