Towards Universal Broadband:

Flexible Broadband Pricing and the Digital Divide

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August 2009

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Pricing Flexibility and Broadband Adoption:

Reaching Universal Access through Affordability at All Income Levels[1]

Driven by the conviction that the widespread use of broadband can support economic recovery and help the United States achieve other important national goals, President Obama has proposed that every American should have the opportunity to connect to broadband service. On his campaign web site, the President declared: "America should lead the world in broadband penetration and Internet access" and he promised to bring "true broadband to every community in America."[2] In enacting the American Recovery and Reinvestment Act of 2009, the Congress signaled its agreement by providing $7.2 billion in dedicated funding to advance broadband's spread and by directing the Federal Communications Commission to develop a national strategy to achieve universal broadband.

By historical standards, access to broadband already has progressed at a remarkable pace. The service was introduced only ten years ago; yet, by early 2009 more than 6 in 10 American households subscribed to some form of broadband service for use in their home.[3] Businesses also have become wired for broadband at rapid rates, and millions of Americans also are using a growing variety of mobile devices to connect to the Internet with wireless broadband. These trends clearly show steady advances in both the deployment of broadband by service providers and the number of Americans subscribing to these high-capacity services. According to the Pew Foundation Internet & American Life Project, the percentage of homes connected to broadband service increased from 33 percent in spring 2005 to 63 percent in spring 2009.[4]

However, the data also show that the march towards universal broadband access has progressed unequally across demographic groups. More than a decade after the Commerce Department first flagged the existence of a "digital divide" in Internet connectivity between black and white Americans and between less affluent and wealthier Americans, significant gaps remain.[5] Pew's 2007 survey suggested that the racial divide was closing at an

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[1] The Georgetown University Center for Business and Public Policy provided support for this research. The views and analysis are solely those of the authors.

[2] BarackObama.com, "Organizing for America: Technology." http://www.barackobama.com/issues/technology/index_campaign.php

[3] John Horrigan, "Home Broadband Adoption 2009," Pew Internet & American Life Project, June 2009. http://www.pewInternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf

[4] *Ibid.*

[5] U.S. Department of Commerce, "Falling Through the Net: A Survey of 'Have Nots' in Rural and Urban America," July 1995. http://www.ntia.doc.gov/ntiahome/fallingthru.html.

encouraging rate, and some news accounts declared that the racial divergence was a thing of the past.

Our difficult economic times have reversed these trends over the past two years, and the broadband access gap between African-Americans and white Americans widened in both 2008 and 2009.[6] Broadband adoption among African-Americans rose only slightly in 2008 and 2009 following several years of much more substantial increases. Meanwhile, broadband adoption by white households continued to rise steadily. As a result, the broadband-access gap between the races was wider in 2009 than it had been in 2005 (Table 1, below). A significant rural-urban gap in broadband uptake rates also has persisted, as rural Americans increased their broadband access at about the same pace as those who live in cities and suburbs.

Table 1. Home Broadband Adoption by Race, Percentage[7]

Ethnicity	2005	2006	2007	2008	2009
White	31	42	48	57	65
African-American	14	31	40	43	46

Gaps in broadband uptake rates also persist across household income categories. The Pew Survey, for example, found that among Americans with the highest incomes, broadband is approaching universal adoption. About eight of 10 Americans with incomes ranging from $75,000 to $100,000 had broadband access at home in the spring of 2009, as did 88 percent of those with incomes of $100,000 or more. By contrast, just over one-third of households with incomes of less than $20,000 reported a home broadband connection, and only slightly more than half of households with incomes in the $20,000 to $30,000 range have signed up for broadband at home.

Table 2. Home Broadband Adoption by Income, Percentage[8]

Household Income	2005	2006	2007	2008	2009
Under $20,000	13	18	28	25	35

[6] Horrigan 2009.
[7] Horrigan 2009 and John Horrigan, "Home Broadband Adoption 2008," Pew Internet & American Life Project, July 2008 http://www.pewinternet.org/Reports/2008/Home-Broadband-2008.aspx
[8] *Ibid.*

$20,000-$30,000	19	27	34	42	53
$75,000-$100,000	51	67	70	82	82
Over $100,000	62	68	82	85	88

Of course, the differing rates of broadband adoption across racial, geographic and income classes are strongly interrelated. A large portion of the disparity in uptake rates by race and geography, for example, are driven by differences in household income. Studies have indicated that uptake rates also are strongly correlated with education and the need for high speed Internet in the workplace.

These gaps present an important challenge to policymakers and obstacles to the goal of universal broadband. Given the growing trend by individuals to communicate online and the commitment of public and private institutions to shift services and communications to the Internet, any group that disproportionately lacks broadband-based Web communications operates at a significant disadvantage to their broadband-linked peers. Their economic opportunity are reduced; they are cut off from accessing emerging broadband-enabled health care and education services, and they will lack a increasingly prominent communications link with their government.

Despite these persistent gaps, broadband usage continues to spread to all parts of America in line with a general downtrend in its price – a pattern which is fairly typical for the diffusion of other new information technologies. As detailed in a 2006 study, technologies that enhance the quality of people's lives and add value for individuals tend to diffuse across of society as their prices decline.[9]

Respondents to the Pew survey report that their average bills for broadband service fell from $39 to $34.50 between 2004 and 2008. Interestingly, adoption continued to rise in 2009 despite a jump in prices back to the 2004 level. To some extent, the 2009 price levels may reflect the willingness of a growing number of Americans to pay more for premium services that provide even higher speeds. The average monthly cost of basic service stood at $37.10 in 2009, while premium subscribers paid an average of $44.60, according to the Pew Survey. Additionally, economic studies have concluded that households that have adopted broadband Internet are far less price sensitive or "price elastic" than prospective adopters.[10]

[9] Robert J. Shapiro, "Creating Broad Access to New Communications Technologies: build-out requirements versus market competition and technological progress," Sonecon, LLC, April 2006. http://www.sonecon.com/docs/studies/broadaccess_042406.pdf

[10] Kenneth Flamm and Anindya Chaudhuri, "An Analysis of the Determinants of Broadband Access," *Telecommunications Policy* 31 (2007): 312-326.

Small price increases for current broadband subscribers (especially middle and high income subscribers) are unlikely to push them back to dial-up service, but the higher prices can have a larger impact on the subscription choices of households that currently use dial-up (or have no Internet access at all) and are looking to upgrade their service. In this respect, low income households are particularly price sensitive.

These findings are supported by recent experience, which suggests that adoption would have been even higher in 2009 if the price increases had not occurred. Pew reports, for example, that almost one in ten Americans either cancelled or cut back Internet service for financial reasons between April 2008 and April 2009. These cutbacks were greatest at the bottom of the income scale, with 17 percent of households earning $20,000 or less reporting that they reduced or gave up service during 2008.

As policymakers consider the future of broadband policy, they must try to determine whether the historic pattern of technology diffusion will replicate itself with broadband or whether the re-widening of the Internet access gap is a harbinger of new challenges. Specifically, they must ask themselves what would happen to adoption trends if Internet service providers change their consumer pricing models to accommodate additional costs arising from expanded demand for bandwidth. This paper is intended to provide insights into those questions by examining the impact of various pricing approaches and pricing allocations among consumers.

Broadband Prices and Adoption

To be sure, pricing is not the only determinant of broadband adoption trends. Roughly seven percent of Americans who use the Internet rely on dialup connections rather than broadband, and almost one in five of these dialup consumers say that "nothing would get me to switch" to broadband.[11] Among those who use dialup or are not online at all, roughly half indicate they do not have any interest in broadband service. The success of private-public initiatives such as Connect Kentucky suggest that some of this resistance can be overcome through aggressive outreach and "digital literacy" programs that help non-users appreciate the benefits of connectivity.

However, a number of studies *have* found that price is the strongest determinant of broadband subscription. One study, for example, found that at $20 per-month, a 10 percent increase in price reduces demand by 5.3 percent (a price elasticity of demand of -0.53); while at a price of $50 per-month, roughly the then-actual market price, a 10 percent price increase

[11] Horrigan 2009.

reduces demand by 9.8 percent.[12] Another study conducted by Austan Goolsbee, now a member of the President's Council of Economic Advisors, found that significantly larger shares of affluent people were willing to pay higher prices for broadband than less-affluent people.[13] Another analysis found that a 10 percent increase in the price of high-speed connections in 2000 reduced demand for those connections by 10.8 percent overall – but by 15.9 percent among those with incomes below $25,000. For all other income groups, the dip in demand as a result of higher prices ranged from 8.5 percent to 10 percent.[14] And Pew's 2009 survey found that lower prices could persuade dial-up users to switch to broadband and that among those who use dial-up or are not online at all, one-in-five list affordability as the main reason they do not have broadband service.[15]

The range of studies broadly agrees that demand for broadband is price-driven, but the estimates of the price sensitivity range from 8 percent to 27.5 percent for every 10 percent increase in price.[16] The studies also agree that lower-income, rural and less-educated people tend to be more price sensitive in this area than higher-income, urban and better-educated users.

Possible Pressure on Prices

The predominant model of broadband pricing today and throughout the past decade has entailed payment of a flat monthly fee that allows unlimited usage. The fee may vary depending on the speed of the connection, but there is no limit on the amount of time a user may spend on line or the amount of bandwidth capacity he or she may consume. This model worked well during the early days of the Internet, because web access consisted mostly of static, text-based sites that did not require large amounts of bandwidth. The cost of providing service to each subscriber could be calculated by network operators with relative certainty, which in turn enabled operators to set consumer prices at levels that covered their cost of operations and so enabled more Americans to sign up for service.

As the range of Internet-based content and applications has exploded, consumers are using an increasing amount of bandwidth – and differences between various customers' bandwidth use also are increasing. The growing popularity of Internet video, radio and other music sites, along with the increasing use of peer-to- peer networking, have driven up

[12] Paul Rappoport, Lestor D. Taylor and Donald J. Kridel, "Willingness to Pay and the Demand for Broadband Service," mimeo, 2003. http://www.economics.smu.edu.sg/events/Paper/Rappoport_3.pdf

[13] Austan Goolsbee, "The Value of Broadband and the Deadweight Loss of Taxing New Technology," Discussion Paper, University of Chicago, 2006. http://faculty.chicagobooth.edu/austan.goolsbee/research/broadb.pdf

[14] Kevin Duffy-Deno, "Demand for High-Speed Access to the Internet Among Internet Households," ICFC 2000, Seattle, 27 September 2000. http://www.icfc.ilstu.edu/icfcpapers00/duffy-deno.pdf.

[15] Horrigan 2009.

[16] Goolsbee 2006.

bandwidth demand at nearly an exponential rate. While one minute of Internet text browsing requires an average of 2-200 KB of bandwidth, one minute of audio requires about 1,000 KB, and 60 seconds of video consumes 9,000 KB.[17] Moreover, with the rising popularity of mobile broadband devices such as Blackberrys and iPhones, the use of high-bandwidth applications is no longer limited to offices and homes. Cisco Systems, for example, has forecast that Internet traffic will quintuple from 2008 to 2013, driven largely by video and what it calls "visual networking."[18] Furthermore, customers are becoming increasingly heterogeneous in their use of their broadband access.

Keeping pace with this fast-rising demand for bandwidth will require significant expansions in network infrastructure and capabilities, which in turn will entail substantial additional investment by service providers. The precise dollar amounts required are difficult to calculate, in part because they will be affected by technological innovations in networking equipment. But the order of magnitude is likely to be substantially greater than current investment levels.

In one, widely-cited report, EDUCAUSE, a higher-education technology group estimated that providing "big-broadband" to every home and business, with sufficient bandwidth to meet demand, would cost an additional $100 billion over the next three to five years and even larger investments in capacity going forward.[19] Another estimate cited by David McClure, the head of the U.S. Internet Industry Association, and John Ernhardt, Senior Manager of Policy Communications for Cisco Systems, projects that the long-term investments required to keep up with fast-rising bandwidth demand could cost an additional $300 billion over 20 years.[20]

While some of these projected additional investments could be funded by the fees paid by new subscribers, demand for bandwidth by current subscribers is growing smartly and much faster than increases in uptake rates. Therefore, a significant portion of the additional costs to provide expanded infrastructure almost certainly will have to be passed on to current broadband subscribers. Policymakers must consider seriously the impact on access if consumers are asked to pay more and how the pricing framework used to pass along these costs will affect those results.

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[17] Robert J. Shapiro, "The Internet's Capacity to Handle Fast-Rising Demand for Bandwidth," US Internet Industry Association, 14 September 2007. http://www.usiia.org/pubs/Demand.pdf

[18] Cisco Systems, "Hyperconnectivity and the Approaching Zettabyte Era." Cisco Systems White Paper, June 2009. http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/VNI_Hyperconnectivity_WP.pdf

[19] John Windhausen Jr., "A Blueprint for Big Broadband." EDUCAUSE White Paper, January 2008. http://net.educause.edu/ir/library/pdf/EPO0801.pdf.

[20] Davjd McClure, "The Exabyte Internet," U.S. Internet Industry Association, 1 May 2007. http://www.usiia.org/pubs/The%20Exabyte%20Internet.pdf

Therefore, a critical question for policymakers is whether all Internet users should bear these additional costs equally, or is it more appropriate to ask those who use the most bandwidth to pay a higher proportion of those costs. As detailed below, our analysis shows that the way that question is answered could have a significant impact on consumers' ability and willingness to subscribe to broadband services. Existing data show that lower-income Americans already are less likely to sign up for broadband service, in large measure because they cannot afford it. Should this group be asked to subsidize high-bandwidth consumers under a pricing model that charges everyone the same fee, even as many of those households may be deterred from adopting broadband service because they cannot afford to pay a higher share of their income to connect to the Internet. This outcome would almost certainly expand the existing racial, geographic and income gaps.

The link between prices and broadband adoption suggests that higher prices for all consumers will slow the drive to universal broadband and expand the gap that now separates white from African-American and the less affluent from wealthier citizens. As they consider their policy options, the President, Congress, and regulators all need to appreciate the interaction between prices and broadband adoption rates. This study aims to help in their decision-making by examining the impact of illustrative pricing models on adoption rates, especially for those Americans at the lower end of the income spectrum.[21] As noted above, other policy actions may offset the affect of prices. For purposes of this analysis, however, we will examine pricing in isolation from other policy variables.

Simulating the Future of Broadband Adoption

To explore these issues, we model the impact of the additional investments required to avoid Internet congestion and provide access to all American households under different pricing strategies and a variety of other assumptions. First, we generate a baseline projection of broadband uptake by income level under current conditions. We then estimate the deviations from this baseline case for different pricing approaches, in order to illustrate the impact of each approach on the goal of universal broadband access.

Our projection method follows closely the method used in our 2007 study.[22] For ease of presentation, we focus on four scenarios in this study. We also have run simulations of

[21] The paper draws on our earlier work: Kevin A. Hassett and Robert J. Shapiro, "The Impact of Pricing Regulation on Broadband Adoption by Lower-Income Households," mimeo, 2007. http://cbpp.georgetown.edu/62495.html.

[22] The 2007 study is available through Sonecon, LLC. A technical appendix with detailed simulations, including additional ones examining the impact of other pricing strategies and macroeconomic variables, is available from the authors on request.

a number of other scenarios, including several that reflect the impact of the current recession. The recession will delay the achievement of universal broadband by slowing the rate of adoption in the near term, but it should not fundamentally alter longer term trends.

We begin by using the recent broadband uptake rates by income level collected by the Pew Internet and Life Project in 2009. There is survey evidence that the rate of broadband uptake has slowed considerably as the market has reached a mature phase.[23] Accordingly, we assume that the diffusion patterns for broadband access will be similar to those for dial-up Internet access and personal computer ownership. We use data on rates of dial-up Internet uptake by income level from the U.S. Census Bureau Current Population Survey from 2000 to 2003 to predict the increases in broadband uptake through 2011 and then use overall computer adoption rates to simulate increases from 2012 through 2017.

Furthermore, since studies show that rates of Internet uptake are income sensitive, we make additional adjustments to the baseline in order to incorporate expected income increases for each income group in our model. We use the most recent projections of economic growth from the Congressional Budget Office's (CBO) March 2009 report, "A Preliminary Analysis of the President's Budget and an Update of CBO's Budget and Economic Outlook," and assume that the income of each bracket will grow at the rate that CBO projects for the economy as a whole.

What the Simulations Show

In this section, we present the results of a series of simulations that examine how different pricing approaches, macroeconomic factors, and sensitivity assumptions are likely to affect the rate of broadband uptake by income group. Table 3, below, presents the baseline case of broadband adoption in the absence of future price increases.

Table 3. Projected Shares of Households with Broadband Internet, By Income, 2009-2017, Baseline Case: No Price Increases

	2009 (Actual)	Projected Share of Households with Broadband Internet (%)							
Household Income		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Under $30,000	44.1	51.5	60.8	69.1	78.4	87.6	93.2	99.0	99.0

[23] John Horrigan, "Is Home Broadband Adoption Slowing?" Pew Internet & American Life Project, 18 September 2008. http://www.pewInternet.org/Commentary/2008/September/Is-Home-Broadband-Adoption-Slowing.aspx.

$30,000 - $74,999	68.6	74.6	83.0	88.7	92.5	94.5	96.7	98.9	99.0
$75,000 and above	85.5	87.7	92.7	95.8	97.5	99.0	99.0	99.0	99.0

Without any additional charges to customers to finance the additional investment required to accommodate fast-rising bandwidth demand, we would expect to see universal broadband by 2017. [24] It is important that this simulation be seen as a counter-factual scenario, because Internet providers would not be able to make the investments necessary to facilitate universal broadband in the absence of a source of additional revenues. However, for analytical purposes, it is critical to examine this baseline in order to fully appreciate the real world effect of other scenarios. It is instructive to note that without price increases to finance the additional investment required to service the fast-rising demand for bandwidth, President Obama's goal of universal broadband access could be achieved in seven years.

However, as noted earlier in this study, the rapid increases in bandwidth demand associated with the fast-rising use of video and audio applications will compel Internet providers to undertake substantial investments to upgrade their existing infrastructure to maintain service reliability and satisfy customers.

Absent another source of revenue, such as a system that assesses fees on content providers or high bandwidth users, the costs of these additional investments will generate broad price increases substantially larger than those experienced during the expansion of dial-up Internet access. Table 4, below, examines the rate of broadband adoption by income group, taking into account the price increases necessary to finance the additional investment and the relative sensitivity of each income group to these price increases. In this scenario, we assume that those price increases are passed along to consumers in uniformly higher flat, monthly fees.

Table 4. Broadband Access with $300 Billion in Additional Investment and Flat Rate Pricing, By Income, 2009-2017

	2009 (Actual)	**Projected Share of Households with Broadband Internet (%)**							
Household Income		**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**

[24] There may well be year-by-year cost savings from Moore's Law-type advances in electronic circuits. But only a small part of the necessary network expansion costs consists of electronic equipment, and all installed network equipment have long depreciation lives. Therefore, cost reductions from advances in electronic circuits would provide very modest assistance in restraining overall cost growth.

Under $30,000	44.1	51.5	58.1	63.5	69.6	75.3	78.0	80.9	79.4
$30,000 - $74,999	68.6	74.6	80.4	83.8	85.3	85.4	85.9	86.7	85.7
$75,000 and above	85.5	87.7	90.0	90.7	90.3	90.0	88.5	87.4	86.4

These results show a dramatic change in broadband uptake rates based on the price increases related to the necessary, additional investments. While these price increases affect all income groups, the largest impact is felt by lower-income and middle-income families. In the baseline case, the rate of broadband adoption among lower-income households increases by more than 34 percentage points by 2013, compared to a 25 percentage point increase with higher flat pricing. By 2017, almost 20 percent fewer lower-income households adopt broadband Internet compared to the baseline case (79.4 percent, compared to 99.0 percent), and over 13 percent fewer middle-income households purchase residential broadband than under the baseline (85.7 percent compared to 99.0 percent). These results should be instructive to policymakers committed to achieving universal broadband access. Policies that have the effect of forcing providers to pass along their additional investment costs in higher, flat monthly fees may dramatically slow universal access.

The results are very different if we assume the providers can use flexible pricing strategies that charge heavy bandwidth users for their additional consumption. We do not know precisely what form such new pricing models will take and, therefore, we cannot say precisely how costs would be allocated among different groups of consumers. But for analytical purposes, we have tested two scenarios in which price increases are allocated by usage.

Our first scenario uses survey evidence to assume that 20 percent of broadband users account for the large increases in bandwidth demand.[25] Table 5, below, illustrates the impact on broadband subscription rates by income group if 80 percent of the costs of the additional investment are borne by that minority of heavy-bandwidth consumers. Heavy bandwidth users are assumed to be relatively price insensitive, so their broadband subscription rates remain unaffected by price increases. We do not have adequate data to assess this assumption, but it is reasonable given the likelihood that habit formation would drive consumers to continue the practices that have driven their high bandwidth usage to date. To the extent that high bandwidth users are more sensitive to higher prices than we have assumed, companies would have to choose between spreading the cost to lower bandwidth

[25] James J. Martin and James W. Westall, "Assessing the Impact of BitTorrent on DOCSIS Networks," *Proceedings of IEEE BROADNETS 2007, Fourth International Conference on Broadband Communications, Networks, and Systems*, September 2007. http://people.clemson.edu/%7Ejmarty/papers/bittorrentBroadnets.pdf

users, and increasing prices more for high bandwidth users. The results of such a policy should be bounded by the simulations we present here. In this pricing scenario, with 80 percent of the additional cost allocated to the 20 percent of very high bandwidth users, future broadband adoption rates remain generally consistent with the baseline case. Lower-income households' access to broadband rises to 78.3 percent in 2013 and 98.5 percent in 2017 under this flexible pricing approach, compared to 69.6 percent and 79.4 percent under the flat-pricing approach.

Table 5. Broadband Access with $300 Billion in Additional Investment, Flexible Pricing, and 80 Percent of the Additional Costs Borne By Heavy, Price-Insensitive Users, By Income, 2009-2017

Household Income	2009 (Actual)	Projected Share of Households with Broadband Internet (%)							
		2010	2011	2012	2013	2014	2015	2016	2017
Under $30,000	44.1	51.5	60.8	69.0	78.3	87.3	92.8	98.6	98.5
$30,000 - $74,999	68.6	74.6	83.0	88.7	92.4	94.3	96.4	98.6	98.7
$75,000 and above	85.5	87.7	92.7	95.8	97.4	98.8	98.8	98.7	98.7

We next examine a pricing approach in which 50 percent of the costs of the additional investment are borne by inelastic, high-bandwidth consumers and 50 percent of those costs are passed along to all consumers via higher, flat subscription fees. In this scenario, Table 6, below, lower-income households adopt broadband at a noticeably slower pace than they do when the heavy-bandwidth users bear 80 percent of the cost. With all households absorbing half of the total costs of the additional investment, lower-income households increase their rates of broadband access to 75.0 percent in 2013 and 91.3 percent in 2017, compared with 78.3 and 98.5 percent when they bear 20 percent of the additional cost.

Table 6. Broadband Access Rates with $300 Billion in Additional Investment, Flexible Pricing, and the Additional Costs Divided 50-50 Between All Consumers and Heavy Users, By Income, 2009-2017

Household Income	2009 (Actual)	Projected Share of Households with Broadband Internet (%)							
		2010	2011	2012	2013	2014	2015	2016	2017
Under $30,000	44.1	51.5	59.7	66.9	75.0	82.8	87.2	91.9	91.3

$30,000 - $74,999	68.6	74.6	82.0	86.8	89.7	91.0	92.5	94.1	93.8
$75,000 and above	85.5	87.7	91.6	93.8	94.7	95.5	94.9	94.4	94.1

For the purposes of these simulations, we assumed that heavy bandwidth users are relatively insensitive to higher costs. However, flexible pricing that applies to them half or more of the costs of the additional investment required to accommodate their demand could induce heavy users to cut back on their bandwidth demand. In this case, the additional investment costs would be reduced, easing the additional pricing pressures for all broadband subscribers.

Policy Implications

Given the national commitment to achieving universal broadband and considering the growing appetite for online communication, it seems likely that at some future date every American who wants broadband at home will have it. How soon that day will arrive is less clear. Our analysis suggests that the pace at which Americans achieve universal broadband access could differ greatly, depending on economic factors and policy choices including policies that affect how broadband providers defray the costs of the additional investment needed to expand broadband capacity.

On the one hand, the amount of private investment required to ensure that the network can keep pace with growing demand is a key variable. But how that investment is financed, and the extent to which those costs fall on lower-income and middle-income consumers, will be equally important to the goal of universal access.

To the extent that lower-income and middle-income consumers are required to pay a greater share of network upgrade costs, we should expect a substantial delay in achieving universal broadband access. Our simulations suggest that spreading the costs equally among all consumers – the minority who use large amounts of bandwidth and the majority who use very little – will significantly slow the rate of adoption at the lower end of the income scale and extend the life of the digital divide.

If costs are shifted more heavily to those who use the most bandwidth and, therefore, are most responsible for driving up the cost of expanding network capabilities, the digital divergence among the races and among income groups can be eliminated much sooner.

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