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E-economy

Data Memo

BY: **John B. Horrigan, Associate Director for Research**
Aaron Smith, Research Specialist

RE: **HOME BROADBAND ADOPTION 2007**
June 2007

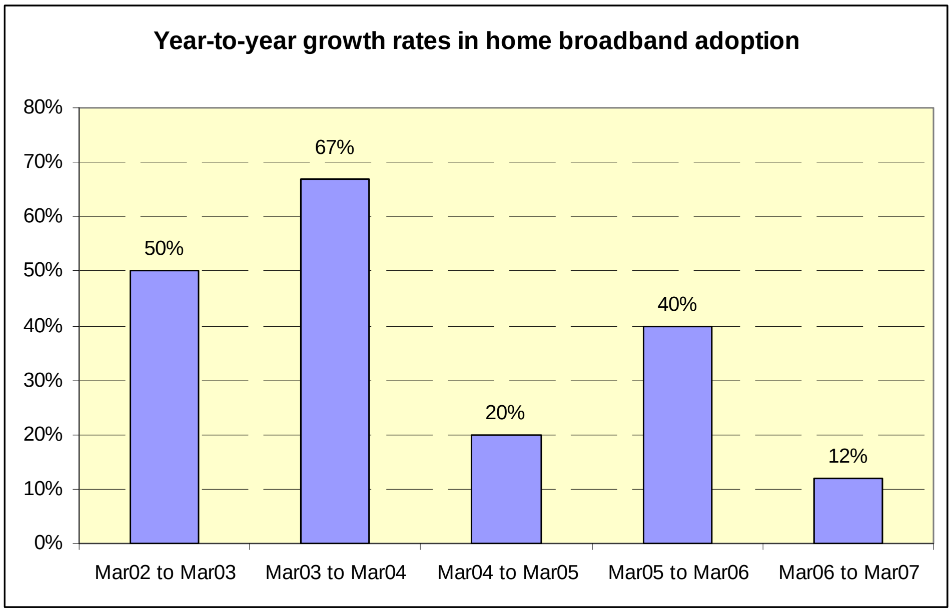
Summary of Findings

- 47% of all adult Americans have a broadband connection at home as of early 2007, a five percentage point increase from early 2006.
- Among individuals who use the internet at home, 70% have a broadband connection while 23% use dialup.
- Home broadband adoption in rural areas, now 31%, continues to lag high speed adoption in urban centers and suburbs.
  - Internet usage in rural areas also trails the national average; 60% of rural adults use the internet from any location, compared with the national average of 71%.
- 40% of African Americans now have a broadband connection at home, a nine percentage point increase from early 2006.
  - Since 2005, the percentage of African American adults with a home broadband connection has nearly tripled, from 14% in early 2005 to 40% in early 2007.

These findings come from a survey of 2,200 adult Americans conducted in February and March of 2007.

Broadband Adoption in 2007

After exhibiting relatively strong growth between early 2005 and early 2006, home broadband adoption in 2006-2007 grew at its slowest rate in recent years. As of March 2007, 47% of adult Americans say they have a high-speed connection at home, up from 42% in early 2006. This 12% year-to-year growth rate is much lower than the 40% rate in the previous period.

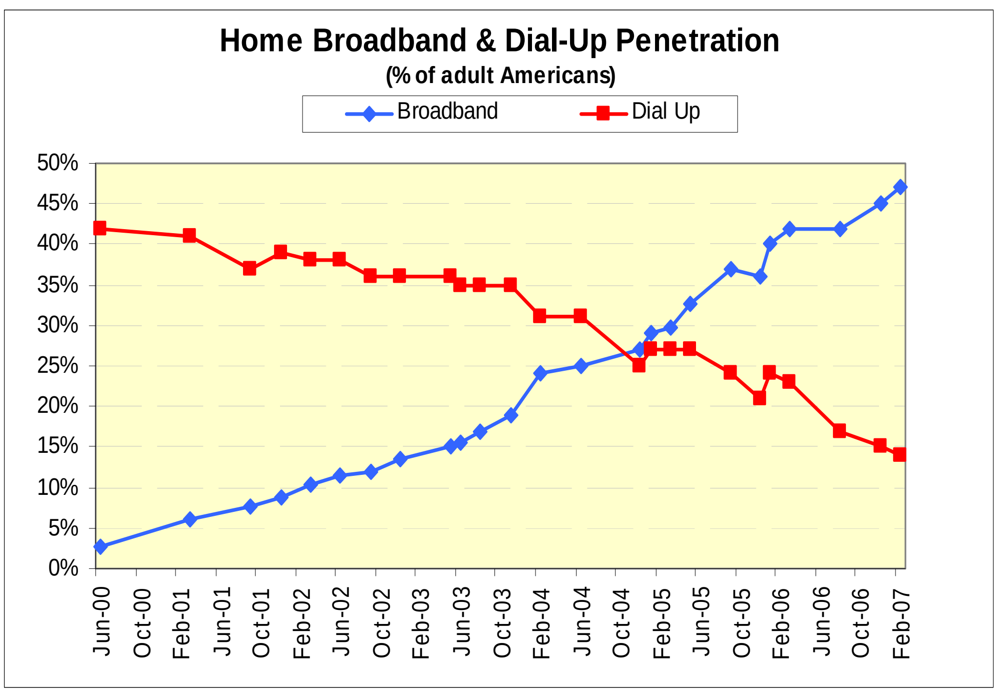


Currently, 71% of adults use the internet at least occasionally from any location; of these, 94% have an internet connection at home. Among adults with a home internet connection, 70% go online using a high-speed connection, versus 23% who use dialup.

A snapshot of internet adoption in the United States		
Internet Users (71% of all adults)	Broadband at home	47%
	Dial-up connection	15%
	Connection type not specified	5%
	Use internet at work only	2%
	Use internet in location other than work or home	2%
Non Users (29% of all adults)	Do not use a computer at work, school, home or elsewhere	27%
	Have access to a computer, but do not use internet or email	2%

Source: Pew Internet Project February-March 2007 survey of 2,200 adults; 966 were home broadband users

Despite relatively slow growth on a percentage basis compared with previous years, the number of home broadband users in early 2007 is now roughly as large (on a percentage basis) as the entire universe of internet users in the first year of the Pew Internet Project's surveys of online use. In June 2000, 48% of respondents reported going online via *any* type of connection to check email or access the Internet, compared with the 47% who have a home broadband connection now.



Broadband Adoption Among Population Subgroups

Historically, high-speed internet adoption has been concentrated among the young, educated and relatively well-off. This trend held to form in our 2007 survey, as several historically broadband-heavy groups continue to have broadband usage adoption well above the overall average for adult Americans. In particular, broadband penetration remains high among Americans ages 18-49, those with annual household incomes over $75,000 and college graduates.

Trends in Broadband Adoption Across Population Subgroups

	% with broadband at home (2005)	% with broadband at home (2006)	% with broadband at home (2007)
All adult Americans	30%	42%	47%
Gender			
Male	31	45	50
Female	27	38	44
Age			
18-29	38	55	63
30-49	36	50	59
50-64	27	38	40
65+	8	13	15
Race/Ethnicity			
White (not Hispanic)	31	42	48
Black (not Hispanic)	14	31	40
Education			
Less than high school	10	17	21
High school grad	20	31	34
Some college	35	47	58
College +	47	62	70
Income			
Under $30K	15	21	30
$30K-50K	27	43	46
$50K-$75K	35	48	58
Over $75K	57	68	76
Community Type			
Urban	31	44	52
Suburban	33	46	49
Rural	18	25	31

Sources: 2005 data comes from the Pew Internet Project's combined January-March tracking survey of 4,402 adults; 1,265 were home broadband users. The margin of error for all respondents is +/- 1.6%.

2006 data comes from the Pew Internet Project's February 15 through April 6 survey of 4,001 adults; 1,562 were home broadband users. The margin of error for all respondents is +/- 1.7%.

2007 data comes from the Pew Internet Project's February-March survey of 2,200 adults; 966 were home broadband users. The margin of error for all respondents is +/- 2.3%.

The 2005-2006 time period witnessed strong growth in broadband adoption across numerous demographic groups. As might be expected given the comparatively modest overall growth in broadband adoption for 2006-2007, growth rates among most population subgroups during the current time period were relatively modest by comparison. However, some demographic groups exhibited rapid broadband growth in 2006-2007 when compared with the adult population as a whole (year-to-year growth rates noted in parentheses):

- Those with annual household incomes under $30,000 (43%)
- African-Americans (29%)
- Residents of rural areas (24%)
- Those with less than a high school education (24%)
- Those who say they have attended some college, but have not graduated (23%)

Americans with annual household incomes under $30,000 are the only major demographic group for which broadband growth rates in 2006-07 (43%) met or exceeded those seen in 2005-06 (40%). Continued strong growth in broadband penetration among low-income households is particularly important both because of the size of this segment (25% of respondents in our February 2007 survey reported annual household incomes of under $30,000 per year) and because these lower income households have long been among the most under-represented groups in home high-speed adoption.

Several groups in particular exhibited low growth relative to the overall average. These include (year-to-year growth rates again noted in parentheses):

- The age 50-64 cohort (5%)
- Those with annual household incomes between $30,000 and $50,000 (7%)
- Suburbanites (7%)

Focus on African-Americans

As recently as early 2005, broadband adoption among African-Americans was just 14%, among the lowest of any major demographic group. However, the past two to three years have brought rapid adoption of broadband by African-American adults. Today 40% of African-Americans have a broadband internet connection at home, an increase from 31% in March 2006.[1] While this figure is lower than the home high-speed penetration rate for whites, it represents a 186% increase since early 2005. Put another way, African-Americans now “trail” whites by just one year with respect to broadband adoption—high

[1] The eight percentage point difference in home broadband adoption among African-Americans in the 2006-2007 timeframe is statistically significant at a 90% confidence level.

speed internet penetration among African-Americans in 2007 is now roughly equivalent to that seen for whites in 2006.

The difference in broadband adoption between African-Americans and whites is due primarily to lower internet usage among African-Americans. Overall, 73% of whites use the internet at least occasionally from any location, compared with 62% of African-Americans. The relatively lower incomes and relatively lower average levels of educational attainment for African-Americans contribute greatly to this gap in internet usage, since individuals with low incomes and education levels (regardless of race) are generally much less likely to use the internet.[2] When whites and blacks who use the internet at home are compared side by side, rates of broadband adoption are similar: 70% of African-Americans who use the internet at home have broadband compared with 69% of whites.[3]

Rural Broadband Adoption

Rural residents have long trailed their counterparts in the cities and suburbs in both internet usage and broadband adoption. As noted above, 31% of rural Americans have home broadband connections, compared with 49% of suburban residents and 52% of urban Americans. Rural broadband penetration still lags considerably behind the levels in non-rural America, but rural broadband continues to experience strong growth rates (albeit from a smaller base of users). Between 2006 and 2007, high-speed internet usage among rural adults grew by 24%, versus 18% for urban residents and just 7% for suburbanites. In the same way that African-Americans "trail" whites in broadband adoption by roughly one year, broadband penetration among rural residents in early 2007 is now roughly equal to broadband penetration among urban/suburban residents in early 2005.

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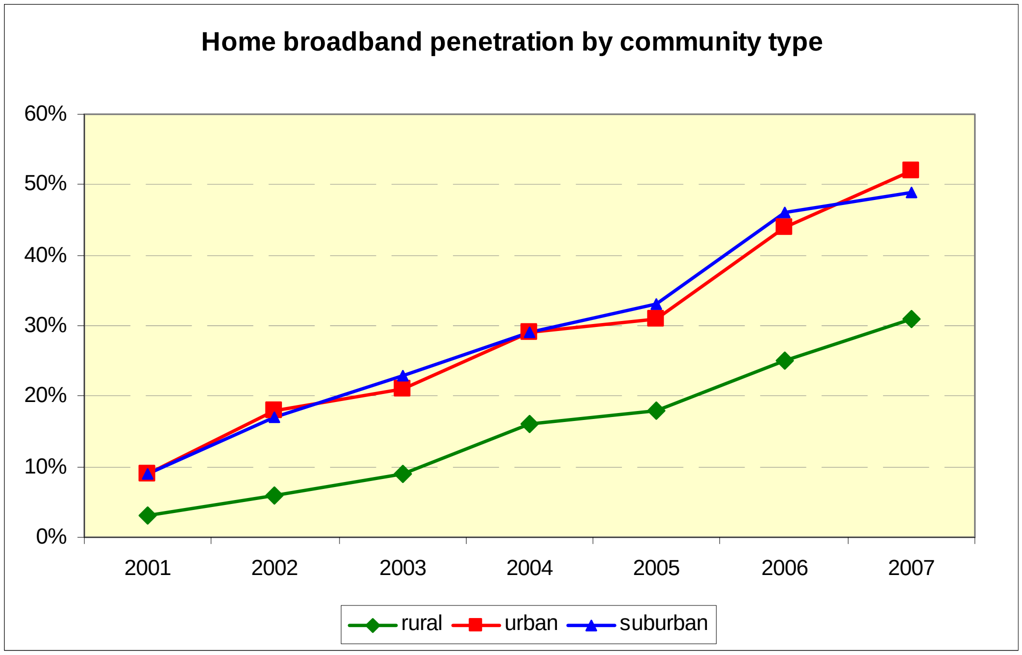
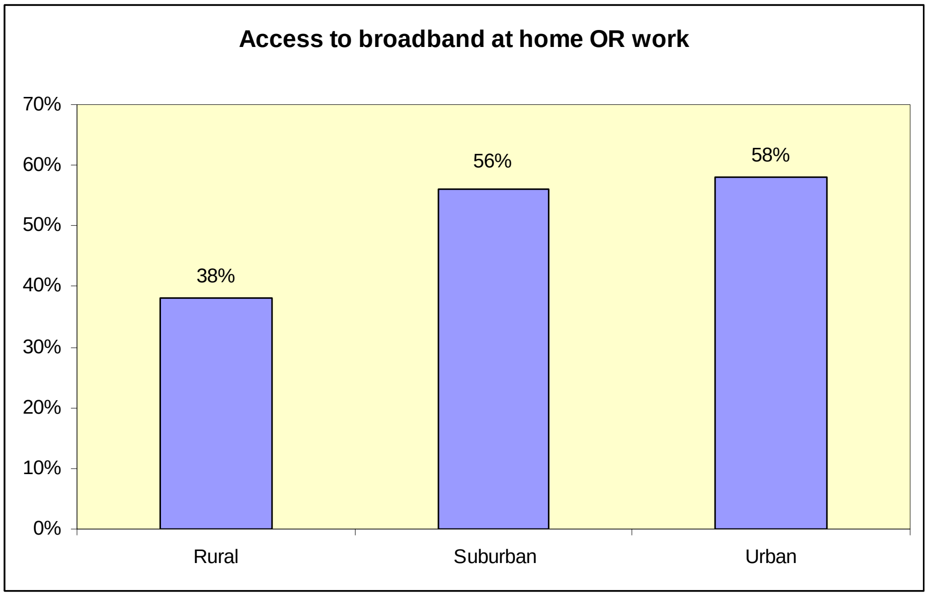
[2] Some 46% of African Americans reported having a household income under $30,000 annually in the February 2007 survey, against the average of 25%. Some 13% of African Americans have eanred college degrees versus 27% of all adult Americans.

[3] The share of internet users who say they have access at home are roughly the same for whites and African-Americans in our February 2007 survey. Some 95% of white internet users go online from home, and 93% of African-American internet users do.



The gap in broadband penetration between rural and urban/suburban residents is comprised of two elements. As with African-Americans and whites, the first element is the low level of overall internet usage among rural residents—73% of urban and suburban residents use the internet at least occasionally, while 60% of rural adults are internet users.

The second element of the rural broadband gap is the relatively low level of broadband adoption among rural residents who do use the internet. Just over half (55%) of rural internet users have a broadband connection at home; among urban/suburban adults, broadband adoption among internet users is 73%. Suburban and urban residents are also more likely to have access to a broadband connection at their place of employment; just over two thirds of rural adults (38%) have access to a broadband connection either at home or at work, versus more than 55% for urban and suburban residents.



Statistical analysis of the survey data controlling for factors such as income, education and age shows that both race and geography are significant factors in predicting overall internet usage. In predicting broadband adoption among internet users, however, the impact of race is negligible—African-Americans and whites with similar demographic characteristics show similar levels of broadband usage.

At the same time, the impact on broadband usage of living in a rural area is negative and significant. While our 2007 survey did not specifically ask respondents whether broadband was available in their area, previous studies have pointed to the lack of infrastructure in rural areas as a contributing factor in the slow growth in adoption of rural broadband, a theory that is consistent with the above findings.[4]

[4] Pew Internet and American Life Project, Rural Broadband Internet Use, February 2006. Available online at: http://www.pewinternet.org/pdfs/PIP_Rural_Broadband.pdf

Latinos and Broadband

From June through October 2006, the Pew Internet Project and Pew Hispanic Center surveyed 6,016 Hispanic adults in order to gauge internet usage habits among Latinos.[5] Respondents were allowed to complete this survey in either English or Spanish, thus painting a more comprehensive portrait of the Latino community than our traditional English-only tracking survey. As a result, this report uses findings from our 2006 Latinos survey in lieu of data collected from "English-only" Latinos in our February-March 2007 survey. Key findings relating to broadband usage among Latinos include:

- 56% of Latinos go online from any location. This is slightly lower than the rate of internet usage among African-Americans (62%) and rural adults (60%).

- 29% of Hispanic adults have a home broadband connection, compared with 31% for rural dwellers, 40% for African-Americans and 47% for the adult population as a whole. As with African-Americans and rural residents, low broadband penetration among Hispanics is influenced heavily by low internet usage within this group.

- Among Latinos with home internet access, 66% have a broadband connection; this is comparable to the overall percentage for all internet users (70%).

Broadband Adoption and Internet Usage Patterns

Previous Pew Internet Project research has highlighted the strong relationship between high-speed internet access and the richness and intensity of the online experience. Compared with individuals with a dialup internet connection, broadband users use the internet more regularly and engage more frequently in a variety of online activities.[6]

Our February-March 2007 survey shows this phenomenon proceeding apace. As the table below indicates, 65% of home broadband users go online from home at least once per day to use the internet or check email, compared with 40% for dialup users.

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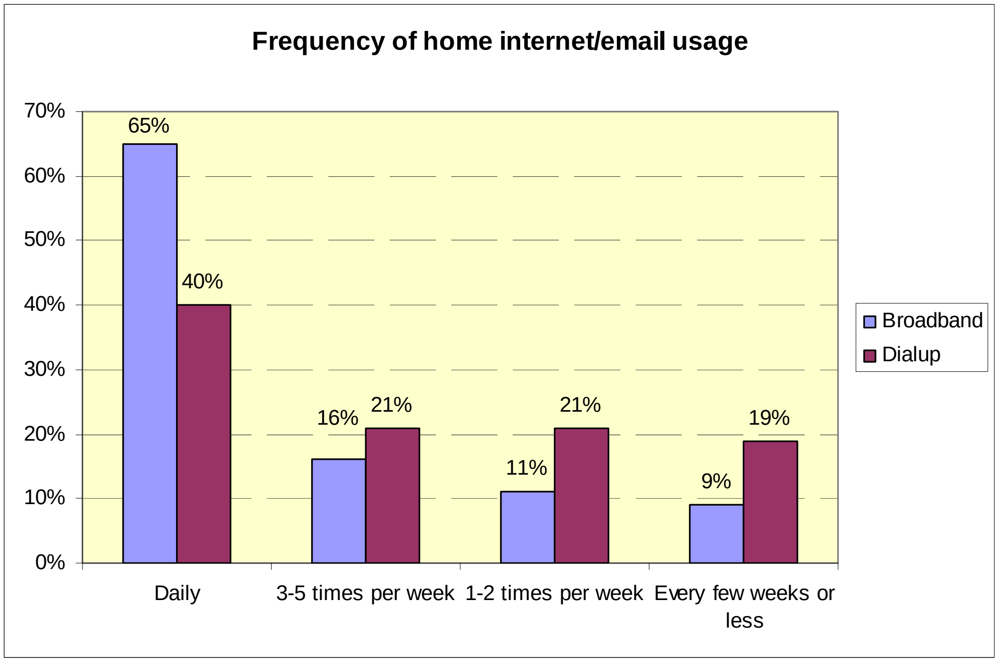
[5] Pew Internet and American Life Project and Pew Hispanic Center, Latinos Online, March 14, 2007. Available online at: http://www.pewinternet.org/pdfs/Latinos_Online_March_14_2007.pdf

[6] Pew Internet and American Life Project, Home Broadband Adoption 2006, May 28, 2006. Available online at: http://www.pewinternet.org/pdfs/PIP_Broadband_trends2006.pdf



In addition to using the internet more frequently than individuals with dialup access, broadband users also participate in a wider range of online activities. It is perhaps not surprising that broadband users exhibit greater rates of participation in bandwidth-intensive activities, such as internet telephony, that are cumbersome and time consuming at dialup speeds. What is particularly notable is that broadband users are also more likely than dialup users to take part in several comparatively low tech (i.e. less bandwidth-intensive) online activities such as searching for information on Wikipedia or reading online news sites.

Percent of internet users who ever engage in the following online activities (from any location)	All Internet Users	Home Dialup	Home Broadband
Send or read email	91%	90%	95%
Look for information about a hobby or interest	83	78	89
Get news	72	61	79
Do any type of research for your job	51	42	57
Look for information on Wikipedia	36	26	42
Look for religious or spiritual information	35	34	37
Read someone else's online journal or blog	29	21	34
Take material you find online and remix it into your own artistic creation	17	11	19
Create or work on your own online journal or blog	12	12	13
Make a phone call online	9	3	11
Create an avatar or online graphic representation of yourself	9	5	11

Source: Pew Internet Project February-March 2007 survey of 2,200 adults; 966 were home broadband users

This broadband effect does not hold true across all of the online activities studied in our March 2007 survey. For instance, demographically similar broadband and dialup users exhibit little difference with respect to ever having looked up religious or spiritual information, or ever having worked on their own online journal or blog. For most activities, however, the presence of a home broadband connection is a key explanatory variable (controlling for demographic and socio-economic factors) in predicting whether a given individual has ever engaged in that activity.[7] This analysis does not necessarily imply that broadband "causes" increased online engagement; those interested in doing certain activities may get broadband in order to pursue those interests. However, a high-speed, "always on" connection clearly allows users to engage frequently in a wider range of online activities than dialup users.

Because broadband users are more likely to go online on a daily basis than dialup users, this tendency among broadband users is particularly pronounced when looking at the activities broadband and dialup users engage in on a typical day.

[7] Multivariate regression analysis shows that the presence of a home broadband connection has a significant positive impact on the likelihood that an individual has ever engaged in numerous online activities, controlling for demographic and socio-economic characteristics such as age, income, race and education (the exceptions being looking up religious or spiritual information, working on a personal journal or blog, and doing job-related research or work).

Percent of internet users who report doing the following activities yesterday (from any location)	All Internet Users	Home Dialup	Home Broadband
Send or read email	56%	43%	65%
Get news	37	24	45
Look for information about a hobby or interest	29	21	34
Do any type of research for your job	23	15	27
Read someone else's online journal or blog	10	5	12
Look for information on Wikipedia	8	9	5
Look for religious or spiritual information	6	4	7
Create or work on your own online journal or blog	5	5	5
Take material you find online and remix it into your own artistic creation	3	3	3
Make a phone call online	2	<1	3

Source: Pew Internet Project February-March 2007 survey of 2,200 adults; 966 were home broadband users

Methodology and data

The findings in this data memo are based on the findings of our daily tracking survey on Americans' use of the Internet conducted by Princeton Survey Research Associates. Most of the data in this report is drawn from the Project's February-March 2007 survey of 2,200 adult Americans. Of these, 1,492 were internet users and 966 were home broadband users. The margin of error for results based on all such respondents is +/-2.3 percentage points; for internet users it is +/-2.8 percentage points; for home broadband users it is +/-3.5 percentage points.

The number of African-Americans surveyed in February-March 2007 came to 190; 111 were internet users, and 71 were home broadband users. For whites, 1,740 respondents were interviewed, with 1,199 internet users and 767 home broadband users.

For **African-Americans**, the margin of error for results based on all such respondents is +/-7.8 percentage points; for internet users it is +/-10.2 percentage points; for home broadband users it is +/-12.8 percentage points.

For **white** Americans, the margin of error for results based on all such respondents is +/-2.5 percentage points; for internet users it is +/-3.1 percentage points; for home broadband users it is +/-3.9 percentage points.

The number of rural Americans surveyed in February-March 2007 came to 447, with 258 rural internet users and 133 rural home broadband users. For residents of urban America, 597 respondents were interviewed, with 422 internet users and 297 home broadband users. The total number of suburban Americans interviewed was 1,156, with 812 internet users and 536 home broadband users.

For **rural** Americans, the margin of error for results based on all such respondents is +/-5.1 percentage points; for internet users it is +/-6..7 percentage points; for home broadband users it is +/-9.3 percentage points.

For **urban** Americans, the margin of error for results based on all such respondents is +/-4.4 percentage points; for internet users it is +/-5.2 percentage points; for home broadband users it is +/-6.3 percentage points.

For **suburban** Americans, the margin of error for results based on all such respondents is +/-3.2 percentage points; for internet users it is +/-3.8 percentage points; for home broadband users it is +/-4.7 percentage points.

For the definition of **community type,** we follow the Census Bureau definition whereby respondents are categorized as "rural" if they reside in a non-metropolitan statistical area (MSA) county. Respondents are categorized as "suburban" if they reside in any portion of an MSA county that is not in a central city. Respondents are categorized as "urban" if they reside within a central city of an MSA.

The sample for this survey is a random digit sample of telephone numbers selected from telephone exchanges in the continental United States. The random digit aspect of the sample is used to avoid "listing" bias and provides representation of both listed and unlisted numbers (including not-yet-listed numbers). The design of the sample achieves this representation by random generation of the last two digits of telephone numbers selected on the basis of their area code, telephone exchange, and bank number.

New sample was released daily and was kept in the field for at least five days. The sample was released in replicates, which are representative subsamples of the larger population. This ensures that complete call procedures were followed for the entire sample. At least 10 attempts were made to complete an interview at sampled households. The calls were staggered over times of day and days of the week to maximize the chances of making contact with a potential respondent. Each household received at least one daytime call in an attempt to find someone at home. In each contacted household, interviewers asked to speak with the youngest male currently at home. If no male was available, interviewers asked to speak with the youngest female at home. This systematic respondent selection technique has been shown to produce samples that closely mirror the population in terms of age and gender. All interviews completed on any given day were considered to be the final sample for that day.

PSRAI calculates a response rate as the product of three individual rates: the contact rate, the cooperation rate, and the completion rate. Of the residential numbers in the sample, 76% were contacted by an interviewer and 41% agreed to participate in the survey. Eighty-seven percent were found eligible for the interview. Furthermore, 94% of eligible respondents completed the interview. Therefore, the final response rate is 29%.

Non-response in telephone interviews produces some known biases in survey-derived estimates because participation tends to vary for different subgroups of the population, and these subgroups are likely to vary also on questions of substantive interest. In order to compensate for these known biases, the sample data are weighted in analysis. The demographic weighting parameters are derived from a special analysis of the most recently available Census Bureau's March 2006 Annual Social and Economic Supplement. This analysis produces population parameters for the demographic characteristics of adults age 18 or older, living in households that contain a telephone. These parameters are then compared with the sample characteristics to construct sample weights. The weights are derived using an iterative technique that simultaneously balances the distribution of all weighting parameters.

washingtonpost.com

Web 2.0 Revives Internet Economy

E-commerce gets a boost with emerging interactive apps and other new online technology.

Len Rust
PC World
October 22, 2007

The emergence of the next generation of Internet technology and applications has led to the coining of the term Web 2.0 to indicate that the Internet now has more capabilities than ever before. The Internet media companies such as Google, News Corp, and Yahoo are just some of the leaders taking advantage of this with the introduction of new services and applications.

This revival of the Internet has also led in part to the re-emergence of the Internet economy, and more specifically e-commerce. The increase in broadband connections is another factor that has led to this revival according to BuddeComm.

Revenue from the large range of content and services available from the Internet is rapidly increasing globally; travel, gambling, adult content, music and health services are particularly popular, and social networking services are flourishing. It is estimated that by 2010 more than US$2 billion will be spent on social network advertising in the US alone. The Internet economy is increasingly relying on the underlying Internet infrastructure for its success, and this has also opened up a range of new support functions for ISPs and business service providers, with some already beginning to diversify.

New video applications have also emerged as the Internet media companies seek to exploit the added speed and capacity of broadband infrastructure. This will result in a whole range of applications continuing to enter the market over the next decade. As can already be observed, the killer application on these networks is video-based communication, nearly half of which is produced by users themselves.

Commercial video entertainment will eventually account for only a quarter of these services. Sites that started as social networks, such as Facebook, are also expanding into video-based services in order to compete. As commercial Web sites try and enter this space, there is no sign of this growth abating.

Web 2.0 technologies have shifted the consumer's Web experience to interactive and collaborative applications, which a growing number of people can access and contribute to. Online payment gateways such as PayPal have facilitated consumer use of e commerce, facilitating services coming to market. The success of social networking and sites based on user-generated content clearly shows that the consumer-led era has begun, heralding the end of those with vested interests being able to control what they present to users. In future consumers will be not only be able to participate actively, they will also be in a position to challenge the way things have been done in the past and expose failures and misconduct.

E-health is also rapidly shaping up as one of the key killer apps on the truly high-speed broadband networks. Around the western world we are facing a massive dilemma in relation to healthcare. New technologies are increasing life expectations and improving our lifestyle. The cost of this, however, is enormous, and we simply cannot afford to finance these huge advances through the public health systems any longer. In countries with proper broadband infrastructure we see e-health shaping up as a way that will allow us to enjoy these advances in medical technology and medical services at a more affordable cost.

The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data

By

Robert Crandall, William Lehr and Robert Litan[1]

High-speed internet access has developed rapidly in the last decade and is increasingly viewed as essential infrastructure for our global information economy.[2] For example, as recently as mid-2000 there were only 4.1 million broadband lines in the United States and only 3.2 million of these were residential lines.[3] Thus, in mid-2000 less than one household in thirty could access the internet at a download speed of 200 kbps or greater. Six years later, the number of broadband lines, excluding mobile wireless connections, had soared to more than 53.5 million, 49 million of which were in residences. Residential penetration had therefore risen to nearly 50 percent by the middle of last year. (If mobile wireless connections are included, total U.S. broadband lines had risen to more than 64.6 million lines.)

While most communications sector analysts concur that the ability to deliver broadband communications is a critical feature of the modern global communications infrastructure, there is limited recent empirical research on the economic effects of broadband. In particular, much of the available research is now several years old or refers to the benefits of the Internet generally or more broadly of the "digital economy" rather than to the broadband telecommunications infrastructure per se.[4]

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[1] Robert Crandall and Robert Litan are Senior Fellows in the Economic Studies Program at the Brookings Institution. William Lehr is a Research Associate with the Communications Futures Program at MIT. The authors are grateful for the excellent research assistance of David Burk of Brookings.

[2] In 2004 President Bush stated that: "This country needs a national goal for…the spread of broadband technology. We ought to have…universal, affordable access for broadband technology by the year 2007, and then we ought to make sure as soon as possible thereafter, consumers have got plenty of choices when it comes to [their] broadband carrier" (see http://www.whitehouse.gov/infocus/technology/economic_policy200404/chap4 html). Similar positions have been adopted in Europe, where the European Commission has concluded that "widespread and affordable broadband access is essential to realize the potential of the Information Society" (see http://ec.europa.eu/information_society/eeurope/2005/all_about/broadband/index_en htm); in Australia, where a government report concludes that "ubiquitous, multi-megabit broadband will underpin Australia's future economic and social prosperity" (see http://www.dcita.gov.au/communications_for_consumers/internet/broadband_blueprint/broadband_blueprint_html_version/chapter_one_broadband_as_critical_infrastructure); in Japan, where the Japanese have joined with regional partners to "enable all people in Asia to gain access to broadband platforms" by 2010 (see http://www.dosite.jp/asia-bb/en/pdf/abp005.pdf); and other countries.

[3] See Table 1 in *High-Speed Services for Internet Access: Status as of June 30, 2006,* Federal Communications Commission, January 2007.

[4] For example, see Crandall & Jackson (2001), Lehr, Osorio, Gillett & Sirbu (2005), or Litan (2005) for some of the most recent work available.

This study provides new estimates of the effects of broadband penetration on both *output* and *employment*, in the aggregate and by sector, using state level data. We estimate these benefits by using FCC data on broadband penetration for the lower 48 states over the 2003-05 period, controlling for a variety of other factors that also could account for the growth in output and employment during this time. Although the FCC's definition of broadband is broader than we would like – since it includes all connections of 200 Kbps and faster at a time when broadband speeds are routinely greater than 1 Mbps – the FCC penetration data are the most comprehensive and reliable source of such information currently available.[5]

We find that nonfarm private employment and employment in several industries, is positively associated with broadband use. More specifically, for every one percentage point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3 percent per year. For the entire U.S. private non-farm economy, this suggests an increase of about 300,000 jobs, assuming the economy is not already at "full employment" (the national unemployment rate being as low as it can be with a low, stable rate of inflation). At a more disaggregated level, we find that employment in both manufacturing and services industries (especially finance, education and health care) is positively related to broadband penetration. We also find that state output of goods and services is positively associated with broadband use, although probably because of noise in the underlying data, our estimates are not statistically significant.

Because broadband is an important basic infrastructure that is expected to produce spillover and wide-reaching benefits across the economy, it will take time for the full effects of broadband to be realized. And, as we explain further below, measuring the impact of broadband will present an ongoing challenge for economists and other analysts that is especially acute at this early stage in broadband's lifecycle. The early indications of significant positive economic impacts presented here on key macroeconomic data such as jobs and output growth is indicative and supportive of the widespread view that broadband is indeed essential infrastructure.

These results are comforting in light of the fact that significant additional investment in last-mile broadband and complementary infrastructure is occurring as broadband continues to evolve. This investment will increase the capabilities of broadband to support higher data rates and new services, while at the same time contributing to expanding the range of facilities-based "bit paths" into the home, increasing consumer choice and intensifying broadband competition.

The finding of the strong link between broadband use and state-level employment has important policy implications, both on the demand-side and the supply-side. In

[5] The original rationale for selecting 200 Kbps was due in part to a desire to exclude ISDN (128Kbps) and satellite service offerings (which earlier relied on a dial-up connection for the uplink and so failed to deliver the "always on" capability commonly associated with broadband). At this writing, there are efforts in Congress to pass legislation that would refine broadband data collection efforts, including defining higher data rate services.

particular, these results suggest that all levels of government should follow policies that encourage broadband competition, which will lead to lower prices and hence greater use. It should be noted, however, that increased use will require an expansion of supply, specifically greater investment by service providers in broadband infrastructure, which already is facing capacity constraints as new applications, such as video streaming, become ever more popular. It is critical, therefore, that new regulatory policies not reduce investment incentives for these carriers.

Economic Impacts of Information Technology and Broadband

Since the invention of computers in the middle of the last century, what can be broadly labeled as Information Communications Technology (ICT) has become faster, cheaper, and more important and ubiquitous – not only in the United States but throughout the world. The first generation of computers consisted of expensive mainframes tended to by a specialized cadre of computer technicians. In the 1970s, with the development of more modular and distributed systems such as minicomputers, computing began to spread from Fortune 500 to medium and smaller sized businesses and to a wider range of industries. Mass market computing only emerged in the 1980s with the spread of personal computers (PCs) for use by non-ICT specialists and new business productivity software applications like electronic spreadsheets.

Quickly, it became apparent to users that PCs were more useful if networked so that they could share and access data located on other machines. Local area networks (LANs) and wider-area data communications services to tie these networks together were deployed widely across businesses in the latter half of the 1980s. As PC use spread, increasing numbers of professionals could take advantage of data communication services such as electronic mail over the "Internet"[6] – the first mass market data communication network. In turn, telecommunications providers have continued to innovate and invest in improving the “bandwidth” of the network, which has permitted ever increasing speeds of communication.

The ICT Productivity Paradox

Following the oil price shock of 1973, and throughout the 1970s and 1980s, when firms were investing heavily in ICT, productivity growth remained slow, causing many analysts to question the productivity-enhancing impact of ICT. Papers by Bailey and Gordon (1988), Loveman (1988), Morrison and Berndt (1991), Strassman (1990), and Roach (1987), for example, failed to find measurable benefits attributable to ICT. In 1987, Nobel Laureate Robert Solow famously quipped that "we see computers everywhere but in the productivity statistics" (Solow, 1987) thus labeling what became known as the *Information Productivity Paradox*.

[6] The Internet evolved from the government-funded ARPANET research data network launched in 1969 and later based on the TCP/IP suite of packet-switching protocols. It was privatized and opened to commercial traffic in the early 1990s.

With 20/20 hindsight, there are several reasons why it is not surprising that early analysts failed to detect measurable impacts associated with ICT. First, although investment in ICT represented a significant share of total fixed business investment, it still represented only a small share of the total capital stock and ICT-producing sectors accounted for only a small share of total GDP (see Oliner and Sichel, 1994). Further, the early studies of ICT were based on noisy aggregate industry or economy-wide data.

Second, measuring ICT inputs is notoriously difficult, in part, because of the very rapid pace of innovation and continuously declining prices, summed up popularly as *Moore's Law* (the doubling of computing power on semiconductor chips every 12-18 months). Additionally, ICT is used most intensively in the service sectors of the economy (and in service-sector-like business operations of non-service sector firms), for which it is notoriously difficult to measure output.[7] Failure to measure ICT inputs or ICT-derived outputs correctly contributes to measurement problems, making it difficult to observe quantifiable ICT impacts.

Third, and perhaps, most important, ICT is a *general purpose technology* that is used by businesses in many ways to produce many different types of intermediate and final goods and services (Bresnahan & Trajtenberg, 1995). ICT changes the way firms produce goods and services – for example, through just-in-time manufacturing, supply-chain management, and electronic commerce – thereby enhancing the quality of other factor inputs such as labor and non-ICT capital. Furthermore, it takes time for seismic technological changes to reveal themselves and so the benefits from ICT investment are likely to be observable only with a lag of perhaps several years. The fact that ICT may be expected to change firm production functions in so many ways means that measuring ICT's impacts is inherently complex.

A Paradox Resolved

In spite of these difficulties, however, economists with better firm-level micro data were able to observe significant ICT benefits by the mid-1990s (Brynjolfsson and Hitt, 1996; Lehr and Lichtenberg, 1999). Indeed with more time and better data, the significant benefits of ICT were apparent even in aggregate industry-level data and economy-wide metrics (Oliner and Sichel, 2000; Jorgenson, 2001). Indeed, Jorgenson (2001) estimated that ICT added 1.18 percentage points to GDP growth and accounted for 2/3rds of the growth in total factor productivity during the second half of the 1990s at a time when ICT assets accounted for less than 5 percent of the capital stock. Oliner and Sichel (2000) estimated that 56 percent of the growth in labor productivity from 1996 to 1999 could be attributed to ICT. Thus, ICT was credited with playing a critical role in reinvigorating US productivity growth after 1995.

In 2000, the Dot.com boom peaked and was followed by a downturn that adversely impacted the entire ICT value chain which lead and contributed to the general

[7] For example, for management information systems, accounting, customer-service operations, and other support functions. While ICT is also used increasingly in factory automation and manufacturing processes, this is not where the bulk of ICT is employed.

economic recession that began in 2001. In light of this reaction, it is worthwhile asking whether the gains from ICT experienced earlier represented a one-time or temporary improvement in productive efficiency. More recent research suggests that while ICT's contribution to growth is lower than in the last half of the 1990s, it remains sizable. Jorgenson, Ho, and Stiroh (2007) report that ICT contributed 59 percent of the growth in labor productivity from 1995 to 2000 and 33 percent from 2000 to 2005. While the latter contribution is lower, it remains sizable and in excess of ICT's share of capital, demonstrating that excess returns to ICT continue.

The modern literature on ICT impacts recognizes that while ICT can produce important benefits, the realization of these benefits depends on how ICT is used and on the presence of complementary inputs such as skilled labor and organizational capital. For example, Autor, Levy and Murnane (2003) show that computers have differential effects for different types of work and workers; and Byrnjolffson and Yang (1997) provide evidence that the realization of ICT benefits depends on organizational capital ("intangible assets"). There is also evidence that more intensive ICT use results in higher levels of benefits. For example, Fuss and Waverman (2006) attribute Canada's slower productivity growth (than the U.S.) to its less intensive use of ICT. Indeed, they attribute 60 percent of the difference in Canada's slower labor productivity growth in 2003 to differences in ICT use and its attendant spillover benefits. Looking at firm-level data, Koellinger (2006) finds evidence that that firms that use ICT more intensively innovate more, resulting in larger spillover benefits and productivity gains.

Today, researchers are focusing on better understanding how ICT can be more effective in promoting growth, and in trying to separate one-time from continuous or cyclical growth contributions. While it is clear ICT has added significantly to growth in the past, it is less clear that such growth contributions will continue. One aspect of ICT enhancements is that they may be relatively easily imitated which means that competitive advantage premised on differences in ICT use may be short-lived. This does not mean that ICT will cease to be productive, but rather that the benefits of excess productivity will be captured by consumers who benefit from competitive forces squeezing out excess profit margins. It is also possible that the relative shift in growth contribution -- away from ICT toward non-ICT capital, as noted by Stiroh (2006) – may be because ICT capital is now improving the productivity of complementary non-ICT capital. This makes sense as businesses take advantage of ICT-enabled processes to improve all aspects of firm operations.

The Role of Communications in ICT Productivity Gains

While it is clear that telecommunication services, including data communications, are an essential complement to effective computer use, most of the studies of ICT productivity have focused on the role of computers alone, or have failed to separately identify the contribution from telecommunication services. Thus, while the literature on this subject is relatively thin, the available evidence demonstrates that telecommunications has been important, and is consistent with the earlier finding that ICT in general has produced measurable benefits.

For example, Roller and Waverman (2001) looked at growth across 21 OECD countries from 1970 to 1990 and found that about 1/3rd of the per capita GDP growth (0.59 of the 1.96 percent per year growth rate) could be attributed to telecommunications infrastructure investments. By its very nature, we would expect that investments in basic infrastructure would yield spillover benefits, but Roller and Waverman's results show that these investments yield excessive returns compared to other forms of infrastructure. In a more recent study, Waverman, Meschi, and Fuss (2005) conclude that in developing countries, 10 percent higher mobile phone penetration would result in 0.59 percent higher GDP growth.

Other analysts find similar results. For example, Yildmaz and Dinc (2002) find telecommunications infrastructure promotes productivity growth in service sectors, based on a state-level study of the United States. Greenstein and Spiller (1995) similarly find that investments in advanced telecommunications infrastructure helps explain growth in consumer surplus and business revenue.

Prior Estimates of Economic Impacts of Broadband

To users of computers and other information technology, it is obvious that these are more powerful when networked. The growth in data communication services has complemented the growth in computing usage. Just as PCs heralded the emergence of mass market computing, so the rise of the Web and the Internet in the 1990s, heralded the rise of mass market computing services. It is inconceivable today to imagine purchasing a home or office computer and not being able to use email, access the Web, or use the Internet to share files among users. While usage statistics demonstrate the huge impact the Internet has had on our economy, our ability to measure economic benefits suffers from the same problems that plagued early attempts to measure the impact of ICT. However, preliminary studies suggest that the contribution of the Internet to economic growth is likely to be significant. For example, Varian, Litan, Elder and Shutter (2002) show that U.S. firms have adopted Internet business solutions more intensively than European firms (which may offer yet another reason why U.S. productivity growth has outstripped European growth over the past decade). Based on a survey of over 2,000 firms across the economy, they find that Internet business solutions already have added significantly to business revenue growth and cost-savings (a net gain of almost $600 billion in the U.S. by 2001) and they estimated that Internet business solutions will add 0.43 percentage points to future productivity growth through 2011.

The mass market success of the Internet in the 1990s was based on intermittent, slow speed dial-up connections. The limitations of such connections imposed a severe bottleneck on the usability of the Internet and its ability to deliver interactive, rich multimedia services. Broadband services offering at least an order of magnitude improvement over dial-up data rates and always-on connectivity were needed for the Internet to realize its true potential and to make it feasible to better realize the potential of embedded ICT investments. The emergence of ICT-powered enhanced healthcare, telecommuting, and realization of economic growth benefits in communities in rural areas (the "death of distance") depend on the widespread deployment of broadband services.

Broadband services began to be rolled out in the last half of the 1990s (with cable modems first, see Gillett and Lehr, 1999). In the early days, broadband adoption was relatively low and lacked critical mass, thus limiting the realized benefits of complementary broadband-specific content and services. For example, contrast the almost daily proliferation of new sources of rich media (YouTube, Flickr, SecondLife, etc.) available for the broadband-empowered mass market to what was available back in the early days of broadband's roll-out when the vast majority of users were still accessing content via narrowband dial-up connections.

Because the benefits of broadband – just as with ICT in the early days – will take time to reveal themselves, there have been few studies that have sought to estimate the economic impact of broadband. Lacking data of actual experience, early studies sought to project economic benefits based on well-reasoned analysis of how broadband would be likely to impact future growth. For example, Crandall and Jackson (2001) estimated that ubiquitous deployment of broadband may result in $500 billion worth of economic growth. Using a community-level panel data set, Lehr, Gillett, Sirbu and Osorio (2005) estimated that communities with broadband experienced faster job and firm growth, and realized higher rental rates than non-broadband communities. Vickrey (2004) notes additional early evidence from several firm-level studies for various OECD countries such as Zeed and Hagen (2005) for Sweden and Ministry of Science, Technology, and Innovation (2005) for Denmark.

The Effect of Broadband Subscriptions on State Employment and Output

As we have just shown, there is a growing empirical literature on the effect of high-technology capital, including telecommunications equipment, on output and productivity. Most of this literature antedates the recent surge in broadband in the United States and elsewhere. As a result, the most common measure of new technology in these studies is "information and communications technology" (ICT), not broadband or other advanced telecommunications services. To the extent that there have been studies that examine broadband deployment, the focus is primarily on the determinants of broadband penetration, not on the effects of this penetration on the economy.[8] In what follows, we make a modest attempt to estimate how differences in broadband penetration across the U.S. affect state-level employment and output.[9]

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[8] In particular, see Aron and Burnstein (2003), Garcia-Murillo and Gabel (2003), Deni and Gruber (2005), and Wallsten (2006).

[9] We do not attempt to estimate the effects on state-level *productivity* because accurate data on capital stocks by state are not available.

Preliminary Considerations

As explained above, we recognize that it is still early in broadband's lifecycle for us to expect to measure its full impacts, and furthermore, detecting broadband-specific contributions to growth can be expected to be difficult in light of the many other factors that account for differences in growth across states.

For example, the geographic center of U.S. population and economic activity has been moving steadily westward and slightly southward for decades. During the Civil War, the center of U.S. population was located in southern Ohio; today, it is in south-central Missouri (U.S. Bureau of the Census). As population moves, so does economic activity. To some extent, this migration is affected by state government policies, but some of the shift is likely also due to the attractiveness of living in western and southwestern states due to weather and the availability of housing. In addition, immigration has obviously contributed to the growing population of these states.

Our analysis focuses on the recent growth in employment and output across the lower 48 states. We exclude Alaska and Hawaii because they are remotely located relative to the contiguous lower 48 states. We have output (GDP) data on a state-by-state basis from the Bureau of Economic Analysis through 2005 and employment data from the Bureau of Labor Statistics through 2006. We therefore report results on the growth of each for 2003-05 and 2004-05.[10]

Empirical Method

We test the proposition that growth in employment and output depends on a number of factors. Low business taxes, low levels of unionization, and relatively low wages should attract business investment while a favorable climate and educational opportunities – as well as strong demand for labor – should induce workers to move to a state. We test the significance of each of these factors in our regression estimates. In addition, and the principal focus for this study, we use the number of broadband lines per 100 persons in the state as a measure of the extent to which broadband services are being used, and thus, the importance of broadband to businesses and individual consumers.[11] Table 1 summarizes the data used in this study.[12]

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[10] The results for employment through 2006 are very similar to those reported for 2003-05 and 2004-05.

[11] For broadband to enhance productivity, the technology must be used; penetration provides a measure of adoption and, therefore, use. Further, before broadband may be used, it must first be available and in earlier studies, availability has been employed as a proxy for use (see Lehr, Gillett, Sirbu and Osorio, 2005).

[12] Mean values and standard deviations of our variables may be found in the Appendix.

Table 1
Variables Employed in Empirical Analysis

Dependent Variables: **Name**	**Definition**	**Source**
EMP	Private Nonfarm Employment (000s)	Bureau of Labor Statistics
GDP	Gross Domestic Product –Nonfarm Private Sector ($millions current)	Bureau of Economic Analysis, U.S. Department of Commerce
Explanatory Variables: **Name**	**Definition**	**Source**
BB LINES/CAP	Broadband Lines/Population, December 31	Federal Communications Commission
TEMP	State Mean Annual Temperature, over 1971-2000 (degrees Fahrenheit)	National Oceanic and Atmospheric Administration, U.S. Department of Commerce
TAX	State Business Tax Climate Index (1-10; Higher number indicates lower business tax burden)	Tax Foundation
UNION	Union Membership Share of Employment	Current Population Survey, Bureau of Labor Statistics
EDUC	Education – Share of College Graduates in Adult Population	Current Population Survey, Bureau of Labor Statistics
WAGE	Average Hourly Earnings –Nonfarm Private Sector	Bureau of Labor Statistics
Nine Census Regions	Regional (Dummy) Variables	Bureau of the Census

To estimate the effect of each of our explanatory variables on state employment or output we use ordinary least squares regression analysis.[13] Our dependent variables are the ratio of employment or output in 2005 to its level in 2004 or its level in 2003. Thus, our dependent variable is equal to one plus the growth in employment or output between 2004 and 2005 or between 2003 and 2005. For the 2005/2004 equations, we use the values of our explanatory ("independent") variables in 2004; for the 2005/2003 equations, we use the values in these explanatory variables for 2003.[14] Because there are many potential variables that vary across the regions of the country that we cannot hope

[13] This has the virtue of being straight forward and simple. More complex econometric techniques which we tested failed to yield substantively different or more informative results, which is not surprising in light of the size of our sample and the quality of available data.

[14] We use the same value for the business tax climate in both equations because the Tax Foundation does not publish annual values of this variable.

to measure, we also include separate "dummy" variables for each of the nine Census regions. We estimate these equations for the entire nonfarm private sector and for separate 2-digit industries, such as manufacturing, business services, financial services, etc.

Aggregate Nonfarm Sector Results

Our regression results for the entire nonfarm private sector confirm a strong role of broadband lines and business-tax policy in the growth of employment (see Table 2.) The results for growth in nonfarm private output (GDP), shown in Table 3, also consistently show a positive effect from broadband, but fail to be statistically significant.[15] As already noted, in light of the challenges of observing *any* broadband-specific effect, the lack of significance is disappointing but hardly surprising.

The focus of our interest is on that the coefficients of our broadband variable, **BB LINES/CAP**, and they are positive and generally significant in the employment growth equations. We note that adding the Census region dummies improves the significance of the estimated coefficient. Moreover, as expected, the magnitude of this effect increases as we increase the period of growth from 2004-05 to 2003-05, which is consistent with the interpretation that broadband benefits accumulate over time. Looking at column (3) in Table 1, we see that the estimated coefficient for **BB LINES/CAP** is 0.223 for 2004-05. This means that an increase in broadband lines of 0.01 lines per capita, from its average value of about 0.12 in 2004, increases the growth in employment between 2004 and 2005 by 0.00223, or 0.2 percentage points.[16] This is a substantial impact in just one year. If we look at the results displayed in column 6 of Table 1, we see that the estimated coefficient for **BB LINES/CAP** is 0.593 for 2003-05. Thus, the estimated effect on employment growth of an increase of 0.01 lines per capita is almost 0.6 percent growth in employment between 2003 and 2005. In both cases, the estimated effect is statistically significant, and our equations explain roughly two-thirds of the variance in employment growth across the 48 states, as reflected in the adjusted R^2 shown in the last column of the table.

It is noteworthy that the only other variables that are consistently statistically significant are the business-tax environment in the state and the state's location in the (western) Mountain Census region. The **TAX** variable increases with the degree to which the state creates a favorable business tax environment, *i.e.*, has lower taxes. Therefore, our result suggests that employment grows more rapidly in states with a "healthier" business tax climate. A location in the Pacific or South Atlantic region also contributes positively to employment growth but less significantly. The union variable is not statistically significant.

[15] Each table shows the estimated coefficient and its related "t-statistic," a measure of the coefficient's statistical significance. A t-statistic greater in absolute value than 2.0 generally indicates that the coefficient is statistically significant at the 95 percent confidence level.

[16] It is possible that our single equation, estimated by ordinary least squares, is also capturing the effect of employment or output growth on broadband demand. However, when we estimate the equation using a two-stage, instrumental variables approach, we obtain virtually the same estimated coefficients for our principal independent variables, including broadband lines per capita.

Table 2
Regression Results: Employment Growth in Non-Farm Private Sector (48 States)

Variable	(1) EMP-05/ EMP-04	(2) EMP-05/ EMP-04	(3) EMP-05/ EMP-03	(4) EMP-05/ EMP-03
Constant	1.005*** (32.08)	0.994*** (39.44)	1.036*** (17.95)	1.042*** (22.89)
BB LINES/CAP	0.175 (1.47)	0.223* (2.39)	0.455 (1.84)	0.593** (3.23)
TEMP	0.000 (-1.11)	0.000 (0.01)	-0.001 (-1.62)	0.000 (-0.26)
TAX	0.008** (3.21)	0.004* (2.46)	0.014** (3.43)	0.009** (2.91)
UNION	-0.001 (-1.43)	0.000 (-0.42)	-0.002 (-1.66)	0.000 (0.40)
EDUC	-0.14 (-1.20)	-0.102 (-1.11)	-0.319 (-1.90)	-0.116 (-0.89)
WAGE	0.000 (0.20)	-0.001 (-0.45)	0.001 (0.21)	-0.006 (-1.74)
ENC		0.001 (0.14)		-0.004 (-0.36)
ESC		0.009 (1.01)		0.011 (0.79)
MA		0.009 (1.15)		0.007 (0.58)
MT		0.033*** (5.20)		0.055*** (5.31)
PAC		0.018* (2.35)		0.022 (1.72)
SA		0.012 (1.64)		0.022 (1.94)
WNC		0.012 (1.99)		0.012 (1.24)
WSC		0.002 (0.24)		0.000 (-0.026)
Adj. R-squared	0.241	0.646	0.295	0.686

t-statistics in parentheses
*- Statistically significant at the 5 % confidence level
**- Statistically significant at the 1 % confidence level
***- Statistically significant at the 0.1 % confidence level

The results for output (GDP) growth are less precise, perhaps because the government's estimates of GDP by individual states are less precise themselves. These estimates of state output must be estimated by the Bureau of Economic Analysis from a variety of data, and they are generally revised when Economic Census data become available, but such Censuses are only conducted every five years, and the last one was conducted in 2002. When 2007 Census data become available, the 2003-2005 state GDP data will likely be revised, perhaps substantially.

Table 3
Regression Results: Output Growth in Non-Farm Private Sector (48 States)

Variable	(5) GDP-05/ GDP-04	(6) GDP-05/ GDP-04	(7) GDP-05/ GDP-03	(8) GDP-05/ GDP-03
Constant	1.077*** (18.41)	1.051*** (21.99)	1.145*** (9.83)	1.163*** (11.08)
BB LINES/CAP	0.131 (0.59)	0.161 (0.91)	0.357 (0.72)	0.457 (1.08)
TEMP	0.000 (-0.52)	0.000 (-0.30)	-0.003 (-1.60)	0.001 (0.66)
TAX	0.009 (1.93)	0.005 (1.37)	-0.482 (-1.42)	-0.106 (-0.36)
UNION	-0.002 (-1.99)	0.000 (-0.37)	0.003 (0.35)	-0.006 (-0.87)
EDUC	-0.263 (-1.21)	-0.180 (-1.03)	-0.001 (-0.689)	0.000 (-0.32)
WAGE	0.001 (0.31)	0.000 (-0.01)	0.017* (2.08)	0.010 (1.51)
ENC		-0.009 (-0.65)		-0.035 (-1.32)
ESC		0.009 (0.49)		0.008 (0.25)
MA		0.014 (0.95)		-0.003 (-0.11)
MT		0.055*** (4.66)		0.084** (3.51)
PAC		0.023 (1.55)		0.028 (0.95)
SA		0.028* (2.04)		0.032 (1.22)
WNC		0.026* (2.32)		0.009 (0.43)
WSC		0.051** (2.87)		0.079* (2.36)
Adj. R-squared	0.24	0.634	0.171	0.518

t-statistics in parentheses
*- Statistically significant at the 5 % confidence level
**- Statistically significant at the 1 % confidence level
***- Statistically significant at the 0.1 % confidence level

Nevertheless, the regression results for output growth, shown in Table 3, are consistent with those we obtain for employment growth. The estimated effect of **BB LINES/CAP** is, once again, positive which is consistent with broadband contributing to GDP growth. However, the estimated coefficients are not statistically significant**.**

Empirical Results by Sector

While it is likely that broadband offers benefits across all industrial sectors, we suspect that broadband's contribution to growth may vary by industry sector. Increasingly, individuals use broadband at home to connect to their business offices or even to telecommute. Such activities are more likely to be important in the service industries, such as finance, real estate, or miscellaneous business services. They are unlikely to be as important in construction, mining, or even manufacturing. Therefore, to explore the differential impacts of broadband penetration across the economy, we estimate the equations shown in Tables 2 and 3 for individual 2-digit industries.

The estimated effects of broadband on employment and output growth in each sector are displayed in Table 4. For brevity, we report in Table 4 only the coefficients of **BB LINES/CAP** for equations with all regional dummy variables; the full results may be found in the Appendix. The statistically-significant coefficients are highlighted in the table.

The individual-sector effects generally conform to our expectations. The effect of broadband is most significant in explaining employment growth in education, health care, and financial services, but it is also significant in the 2003-05 growth of manufacturing employment. The latter result is somewhat surprising, as is the lack of an effect on employment growth in real estate.

When we turn to the determinants of sector growth in output, the results once again are less precise. As Table 4 demonstrates, only a few coefficients are statistically significant, but these are once again principally in service sectors. The coefficients for most industries are consistent with the estimated coefficients for employment growth shown in the table. They are simply less precisely estimated.

Table 4
Coefficient of Broadband Penetration in 2-Digit Sector Growth Regressions

	(10) Employment 2005/2004	(12) Employment 2005/2003	(13) Output 2005/2004	(14) Output 2005/2003
23- Construction	2.468 (1.54)	3.892 (1.94)	0.013 (0.05)	0.591 (0.87)
31- Manufacturing	0.371* (2.46)	0.789* (2.59)	0.567 (0.72)	0.577 (0.28)
42- Wholesale Trade	0.098 (0.64)	0.201 (0.83)	0.411 (1.98)	0.710 (1.92)
51- Information	0.169 (0.52)	0.443 (0.65)	0.372 (0.94)	0.315 (0.38)
52- Finance and Insurance	0.273 (1.48)	1.043** (3.09)	0.493 (0.76)	1.900* (2.27)
53- Real Estate and Rental & Leasing	0.125 (0.62)	0.483 (1.31)	0.481* (2.14)	1.584** (2.77)
54- Prof., Scientific, & Technical Services	0.066 (0.31)	0.380 (0.97)	0.194 (0.88)	0.339 (0.80)
55- Management of Companies and Enterprises	0.440 (0.52)	2.081 (1.02)	-0.196 (-0.15)	2.209 (1.28)
56- Admin. & Support, Waste Mgt., and Remedial Services	0.447 (1.69)	1.149 (1.68)	0.896* (2.47)	1.163 (1.64)
61- Educational Services	2.741* (2.73)	4.054** (3.25)	0.299 (1.49)	1.071* (2.08)
62- Health Care & Social Assistance	0.369* (2.50)	0.656* (2.51)	0.121 (0.89)	0.334 (1.40)
71- Arts, Entertainment & Recreation	-0.114 (-0.28)	-0.031 (-0.05)	-0.320 (-1.25)	-0.032 (-0.06)
72- Accommodation and Food Services	0.284* (2.12)	0.361 (1.71)	0.317 (1.89)	0.501 (1.66)
81- Other Services	0.236 (1.47)	0.466 (1.34)	0.289 (1.86)	0.547* (2.46)

t-statistics in parentheses
*- Statistically significant at the 5 % confidence level
**- Statistically significant at the 1 % confidence level
***- Statistically significant at the 0.1 % confidence level

Our empirical investigation of state data on broadband penetration, employment and output thus suggests that employment is rather strongly related to broadband deployment, particularly in certain service sectors, such as finance, education, and healthcare. Surprisingly, even manufacturing employment appears to be related to broadband penetration. To provide some perspective on the estimated size of this effect, we have used the estimated coefficient from our 2005/2003 U.S. employment growth equation to project the increase in 2006 employment from a one percentage point and a three percentage point increase in broadband penetration for the entire United States and for selected individual states. Table 5 provides the results.

Note that a one percentage point increase – equal to roughly 3 million lines – is associated with nearly 300,000 more jobs, assuming that the economy is not already at full employment (or the lowest rate of unemployment that can be achieved with a low, stable rate of inflation). Obviously, such a projection is subject to estimation error and depends on the existence of some slack in the labor market. It is impossible to "create" jobs if the economy is at full employment.

Table 5. Estimated Effect of Increasing Broadband Penetration on Private, Nonfarm Employment, 2006.

	2006 Employment (000)	Increase in Employment from 1 Percentage Point Increase in Broadband Penetration (000)	Increase in Employment from 3 Percentage Point Increase in Broadband Penetration (000)
California	12,625.5	32.4	97.3
Florida	6,909.4	17.6	52.8
Illinois	5,089.0	13.1	39.4
New York	7,125.2	18.5	55.4
Pennsylvania	5,006.8	13.0	39.0
Texas	8,341.0	21.1	63.3
United States	114,184	293.2	879.5

The effect on output growth is less precise, but once again the statistically significant effects of broadband penetration on output growth appear to be concentrated in the service industries. The results are thus consistent with other research that has demonstrated the recent effect of ICT investment on service sector output and productivity.

Policy Implications

Given the increasing evidence of the benefits of ICT in general and of broadband in particular, policy makers should adopt measures that promote, or at least do not inhibit, the growth of broadband. Such policies may be divided into those that affect the demand for broadband services and those that expand the supply of such services. Since the estimates here are derived from state level experience, we close with two basic observations about broadband policies at the state level.

States have few policy levers that affect the overall demand for broadband.[17] However, given that the demand for broadband is price elastic, the most effective policies are likely to be those that contribute to lower prices.[18] The surest route to lower prices is provided by increasing competition in the delivery of broadband services. Federal reform and additional state-specific reforms have focused on reforming "video franchising" laws to reduce barriers to entry and investment by new service providers. We commend such policies as likely to contribute to investment and competition in broadband services.

With respect to the supply side, the most important state policies involve incentives to build network capacity. Federal and state governments should actively seek to remove barriers to new infrastructure investment by incumbents and new entrants. The growth of Internet traffic, especially video traffic associated with such services as YouTube and file sharing traffic associated with a variety of P2P sharing applications, is straining current infrastructure. Providers will need to continue to invest substantially to meet this growing demand without quality-reducing congestion occurring. To understand the magnitude of the capacity challenge, consider that by itself, YouTube currently consumes as much bandwidth as the entire Internet required in 2000, while users upload 65,000 videos and download a staggering 100 million videos every day.[19]

Service providers are now spending billions of dollars per year on expanding the Internet's carrying capacity and speed, in an effort to meet the challenges of rapidly growing demand and competitive pressures to continuously enhance the services offered. The virtuous cycle of capacity investments leading to new services and competition which in turn helps drive increased demand and traffic which in turn leads to still more investment in facilities risks being derailed if the firms investing in such infrastructure cannot reasonably expect to recover their economic costs, including earning a fair, risk-adjusted return on investment. Regulatory rules which unduly restrain provider pricing and service offerings threaten carriers' ability to recover their costs and hence the viability of on-going investment in infrastructure. For example, certain states and members of Congress have proposed so-called "net neutrality" rules that would overly restrict carriers ability to offer differentiated services to address the needs of handling multimedia traffic and recovering the costs from meeting the diverse requirements of broadband consumers.

Finally, there is one important way in which federal policy makers can and should expand both demand and supply of broadband services. That is to continue the process of

[17] Obviously, states may elect to directly subsidize broadband adoption or deployment through targeted economic development or state-funded universal service programs. The logic and viability of such programs need to be evaluated on a state-by-state/program-by-program basis, but care should be given to ensuring that any such programs be implemented so as to be competitively neutral and consistent with market-based competition (avoiding the kinds of implicit subsidies associated with past efforts to regulate access networks).

[18] See Goolsbee (2006).

[19] See Mehlman and Irving (2007) and Kirkpatrick (2006). The term "exaflood" is derived from "exabite", which represents roughly 1 billion gigabytes. As Mehlman and Irving (2007) note, all information generation in 1999 throughout the world totaled two exabytes.

increasing the amount of radio spectrum available for commercial uses and subject to flexible market allocation. Expansion of wireless services will both add to the competitive supply of broadband "bit paths" into homes and businesses and expand the range of complementary services that will further increase demand for broadband capacity. The stronger the competition among broadband providers, the lower prices should go, thereby stimulating demand.

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