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**Broadband and Contributions to Economic Growth: The U.S. Experience and Future
Direction***

There are many ways of examining how broadband relates to economic development. One that comes to mind is a country's global competitiveness. An index for measuring such competitiveness, the Global Competitiveness Index, ranks business competitiveness across 127 countries with the U.S. ranked first in 2007-2008 (Schwab and Porter 2007). The index's treatment of competitiveness is not confined to technology: technological readiness is one of 12 attributes (called "pillars") of a country's relative competitiveness. If we want to better understand the effects of information communications technology (ICT), including broadband, on economic growth and productivity, we might consider the broader context in which ICT is deployed and the conditions under which it has most effectively contributed to economic growth.¹ The measure for economic development, as used in the Global Competitiveness Index, is Gross Domestic Product (GDP) per capita, adjusted for purchasing power parity because it is considered the most comprehensive measure of national economic activity and is strongly correlated to a nation's living standard over time (Schwab and Porter 2007). GDP per capita is not a complete measure of the well being of a country because this metric does not necessarily take into account factors that are often difficult to quantify. For example, oil drilling contributes to GDP but draws down a nation's natural resources, making them unavailable for future use (Rowe 2008). Furthermore, some people may value a quality of life that necessitates a lower economic well being because of trade-offs between certain kinds of economic activity and culture. Nonetheless, GDP per capita is commonly measured across nations and commonly used as a means of comparing economic development, those limitations notwithstanding. Because the private sector is arguably the most effective means of wealth creation, an index that attempts to measure economic competitiveness of the private sector in terms of GDP per capita seems an appropriate place to begin our analysis.

Business competitiveness is inextricably connected to innovation. This point is reinforced in a background essay to the Global Competitive Index by Harvard Professor Michael Porter who described three progressive stages of competitive development in a national economy: factor-driven, investment-driven, and innovation-driven (Schwab and Porter 2007).² The

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¹ The Organisation for Economic Co-operation and Development's (OECD's) commodity-based definition of the ICT sector includes the following broad categories: telecommunications equipment; computer and related equipment; electronic components; audio and video equipment; and other ICT goods. See <http://fiordiliji.sourceoecd.org/pdf/factbook2008/302008011e-07-03-01.pdf>.

² According to Porter, factor-driven economies rely heavily on cheap labor and unprocessed natural resources and focus on labor-intensive manufacturing. They compete on price and are very sensitive to global economic cycles.

countries with the highest levels of competitiveness have innovation-driven economies: in contrast to countries in the earlier stages of development, highly competitive countries tend not to be dependent on imported technologies and are much more inclined to develop technologies. Countries with the most innovation-driven economies tend to make extensive and sophisticated use of ICT. Other significant contextual factors affecting innovation include intellectual property protection, availability of local venture capital, and higher per capita income (Osorio-Urzua 2008). The U.S. is considered a nation with an innovation-driven economy, to use Michael Porter's typology. The circumstances that have contributed to this status as well as the challenges facing its perpetuation are the main thrusts of this paper, which is divided into two parts:

Part I explains the factors that have contributed in past years to the relative success of U.S. businesses to innovate: much of this success is due to their relative speed in adopting the latest information communications technologies and incorporating them into business operations to create new products and processes. Enhanced productivity is found to be associated with those businesses that integrate ICT, including broadband, most intensively into their processes (Forman et al. 2004). The use of ICT, including broadband, also has implications for expanding businesses' capacity to innovate and become more productive, and we discuss those implications in the context of business applications in the U.S. We also discuss the economic impact analyses of broadband deployment on the U.S. and specific states.

Part II briefly explains the challenges facing the U.S. in its efforts to perpetuate its comparative success in global economic competitiveness, at least in the sphere of technological innovation using broadband. Here we deviate somewhat from the metrics of the Global Competitiveness Index and elaborate on four somewhat inter-related debates that, depending on how they affect policy, may impact innovation and thus economic growth in the U.S. in future years: (1) the nature of the U.S. national broadband policy, (2) the digital divide, (3) regulatory barriers to competitive entry, and (4) network management in response to rapidly growing demand for greater bandwidth capacity.

PART I ICT AND BROADBAND: THE INNOVATION ECONOMY

The Broader Context: ICT and the Innovation Economy

There is a time lag for the impact of ICT investments to be realized in a country's economy. One might view these effects in terms of short-term and long-term horizons. In the

Investment-driven economies are efficient producers of more advanced products and technologies than their factor-driven counterparts. However, the designs for products and services still come predominantly from other countries. Innovation-driven economies have the competitive advantage of using the most advanced methods to produce products and services that are differentiated and cutting-edge. Competitiveness in those economies includes sophisticated conditions for the demand of products and services and the presence of supporting industries. Of the three types of economies, innovation-driven economies are most resilient to external economic downturns.

short-term, the relative prices of ICT are reduced, investment in ICT increases, and ICT substitutes for human effort. In the longer term, new technologies are adopted and new products are developed; then new ways of business operation evolve (2010 High Level Group 2006).

Yet, ICT adoption appears to occur in a more complicated manner than is suggested by this two-stage progression. In their study on productivity growth, Van Ark and Inklaar (2005) found that the effects of ICT investments on productivity growth in Europe lagged behind the U.S. from 1995-2004. Indeed, the efficiency gains in productivity in the non-ICT segment of Europe's economy amounted to only 2% from 2000-2004, compared to 50% in the U.S. The question is as follows: What explains this divergence in efficiency gains between Europe and the U.S. during that time period? The Van Ark and Inklaar study suggests that the effects of ICT investments within a country are actually U-shaped: The initial investments in ICT typically result in "hard" savings as the technology becomes increasingly diffused throughout the country. This upswing in productivity is followed by a period of negative productivity growth, as businesses within the country experiment with the technology and learn how to exploit it. During that period, businesses invest in human capital and organizational changes which do not immediately translate into added productivity. Following this experimental phase, there is an increase in productivity when the impact of those new technological applications becomes evident. The U.S. completed this productivity cycle by 2004, whereas the European Union (EU) countries had not within that time frame.³ According to Van Ark and Inklaar, the market services sector (trade and finance) within the U.S. was the biggest investor in ICT services and was more adept than the EU countries in using investments in ICT to develop new ICT-related services. Another study by the Organisation for Economic Co-operation and Development (OECD 2008_a citing Clayton 2006) compares the impact on productivity of ICT investments in U.S. subsidiaries in the United Kingdom with domestic and other multinational firms in the United Kingdom. Once again, the impact on productivity is found to be substantially larger in U.S. subsidiaries, perhaps due to a better use of ICT-generated information or so-called "U.S. management practices" (Ibid 12).

The Van Ark and Inklaar study suggests that ICT investments in marketing (part of the service sector) contributed to greater productivity and possibly also explains the more competitive stance of the U.S. relative to that of European countries. Benefits derived from ICT investments are different in manufacturing and services. Increased productivity in manufacturing comes mostly from procurement and supply chain management, whereas in the service sector those gains come largely from connections to customers (OECD 2008_a citing Clayton 2006). In the U.S., the private service sector in recent years has generally outpaced the goods-producing sector, including manufacturing, in GDP growth.⁴ Therefore, it appears that economic growth

³ Like Europe, Japan also lagged behind the U.S. in using ICT innovatively, a factor that might have contributed to slower labor productivity in Japan than in the U.S. See Information and Communications in Japan 2007.

⁴ This was true in 2003, 2005, and 2006. In 2004, the goods-producing sector reported slightly more robust growth than the private service sector in GDP.

from ICT investments in the future will depend increasingly on service-related companies whose customers can interact effectively with the technology. However, while the national economy might experience greater GDP growth in services relative to manufacturing, it is also more difficult to measure outputs from the service sector than from the manufacturing sector. The ICT-producing segment of the manufacturing sector has been a particularly robust segment of the goods-producing industries in the U.S., and its contributions have greatly exceeded its proportional share of GDP: ICT-producing companies in the U.S. represented only 4% of GDP but contributed more than 11% annually to GDP growth from 2004-2006 and accounted for 15% of real GDP growth during that period (U.S. Department of Commerce 2008).

The *State New Economy Index* (Atkinson and Correa 2007) measures the global competitiveness of states within the U.S. According to this index, the “new” economy and the one toward which states should strive (along the same lines as Porter’s “innovation-driven” economy) is described as “a global, entrepreneurial and knowledge-based economy in which the keys to success lie in the extent to which knowledge, technology, and innovation are embedded in products and services” (Ibid 3). This is another way of describing an economy that makes extensive and intensive use of ICT-enhanced products and processes. A metric used in the *State New Economy Index* to capture the degree to which traditional industries, such as marketing, make use of information technology (and by extension contribute to greater innovation) is the percentage of information technology jobs in non-information technology-related industries.

Innovation is not an objective for a competitive economy but a means of adding value to products or processes: it is through the creative use of labor and other organizational assets that a product or process is improved. And this explains part of the problem in measuring with any precision the economic impact of ICT for the economy of an entire nation. The International Telecommunication Union (ITU) used the analogy of electricity to make the point: “Part of the difficulty is that both ICTs and electricity are ‘enabling’ or ‘General Purpose Technologies’ ...which means that their use and their impacts are ubiquitous yet difficult to measure because they are mainly indirect. It is not electricity or ICTs as such that make the (bulk) impact on economy and society but how they are used to transform organization, processes, and behaviours” (OECD 2008_a). Because people’s skills and their ways of interacting may be affected by ICT, it is difficult to tease out the actual cause of greater productivity. The challenges of what economists call “endogeneity” notwithstanding, recent studies cited by Crandall et al. (2007) offer corroborative support that ICT contributes to productivity growth, especially when ICT is used more intensively and in conjunction with skilled labor and intangible assets. Much of the research also suggests that past experiences with process innovations made firms more likely to be successful in using ICT (Hempell 2002). Moreover, the innovation strategy used by firms really appears to affect the extent to which ICT is used: productivity gained by one firm has spill-over effects for new entrant firms that likewise may adopt similar production processes (Röller and Waverman 2001).

Broadband Applications of U.S. Businesses and the Impact of these Applications on Productivity

Beginning in the latter half of the 1990s, the roll out of broadband in the U.S. changed the array of services this nation's businesses came to expect. In earlier years, Internet connectivity was possible only via narrowband dial-up, but the adoption of broadband with its uninterrupted connectivity exploited the potential of the Internet and related ICT investments (Crandall et. al 2007).

Broadband investments differ from ICT investments in that broadband investments are localized, and demand is also localized. Broadband is only cost-effective if the demand for broadband within the deployment region justifies the cost of investment. Broadband deployment is therefore not evenly diffused throughout the U.S. because some regions are sparsely populated and not in close proximity to more urbanized areas. Private providers need to believe they can recover their investment costs, but in more rural and remote parts of the country it is often difficult to make a business case for those investments. To complicate matters, nobody really knows the extent to which broadband access in the U.S. remains a barrier for subscribership. This lack of information has been due, at least in part, to limitations in the federally prescribed data collection methodology on deployment and subscribership. The Federal Communications Commission (FCC) collects data through its standardized Form 477 filings which were initiated in 2000. The FCC requires broadband providers to report twice a year in Form 477 information about their services and customers. In initial filings, broadband providers were required to report a single list of zip codes per state in which they had at least one broadband subscriber. The FCC modified this requirement in a 2004 order by mandating broadband providers to report technology-specific lists by zip codes.

The problem with this methodology is that some studies⁵ have relied upon it to examine determinants of broadband penetration or availability even though the data represented a report of, at a minimum, only one subscriber in any given zip code. Improperly understood, the effect of this data collection methodology could be to overstate broadband subscription or availability. For example, according to the FCC's estimate as of June 30, 2007, high-speed subscribers were reported to be present in 99% of the most densely populated zip codes and in 91% of zip codes with the lowest population densities (FCC 2008_c), but not that many people actually subscribed to broadband or even could do so if they wanted to. U.S. zip codes averaged 3,300 households as of the 2000 census and are not geographically based areas like census tracts, so any subscribership data based on the FCC's 477 forms are insufficiently granular. Data presented in that manner impede federal, state, or local governments from using them to identify unserved and possibly underserved areas, and perhaps to target policies for areas that seem to have subscription rates that are below what is, from their perspectives, socially desirable. Moreover, the FCC's definition of broadband speed is and, except for reporting purposes, continues to be at

⁵ We briefly discuss two below that rely on data collected from the FCC 477 filings— Gillett et al. 2006 and Crandall et al. 2007.

least 200 kbps in at least one direction which was much lower than existing speeds of most broadband capacity in mid-2007 (FCC 2008_b, ¶ 33). The FCC initiated a proceeding (2007a) to gather comments on modifying the data collection effort, following a critical report by the U.S. Government Accountability Office (GAO 2006).⁶ The GAO report showed that broadband deployment was 12% lower in rural areas relative to urban areas. Furthermore, in addition to population density, broadband drivers include geographical terrain and various demand factors, including the presence of existing provider competition and customer income levels (GAO 2006). Not only are there disparities in broadband deployment and, by extension, subscription within states but also among states.⁷ For example, Ford et al. (2007, Table 1) found differences in residential broadband subscription rates across states; New Jersey had the highest rate of penetration, and Mississippi had the lowest (87% and 25%, respectively.)

Data of a more granular nature should be forthcoming as the result of an order issued by the FCC on March 19, 2008 and released on June 12, 2008. In that proceeding (FCC 2008_a), private providers are directed to report to the FCC the number of broadband subscribers by census tract, disaggregated by detailed speed tiers and technology platforms. However, it may be a year or more before the FCC actually receives the data it specified in the June 2008 order (FCC 2008_a, Statement of Commissioner Michel Copps).

Several studies attempt to estimate the economic impact of broadband deployment in the U.S. but have encountered limitations in the data collected in terms of lack of granularity, use, and up-to-date metrics on speed. These studies often rely on data collected by the FCC in Form 477 filings preceding the FCC's June 2008 order on data collection. Some of these studies focus on the economic impact of broadband on communities across the nation and others on specific states. At the national level, a study prepared for the U.S. Department of Commerce by a group of MIT researchers (Gillett et al. 2006) uses a cross-sectional panel data set of communities, disaggregated by zip code, to analyze the effects of broadband on communities throughout the U.S. between 1998 and 2002. The analysis is based on communities with broadband availability in December 1999, and did not distinguish between the type of provider, technology, or speed level. The authors found that broadband contributed to greater job growth and a greater number of businesses than otherwise would be expected in the absence of broadband. They found no significant impact on average wages; nevertheless, there appeared to be some increase in property value in 2000 attributable to broadband availability in 1999. The authors acknowledged, however, that because they relied upon the FCC data they were only able to analyze broadband availability, not actual use, which would have been their preference (Ibid 5). In a similar vein,

⁶ The FCC (2007a) cited the GAO's recommendation that the FCC "develop information regarding the degree of cost and burden that would be associated with various options for improving the information about broadband deployment." See ¶ 6.

⁷ Deployment is a precondition for subscription, so it seems intuitive that subscription rates will be higher in states with more extensive deployment. For their part, private providers will deploy broadband where they project demand to justify the costs associated with deployment.

Crandall et al. (2007) applied a cross-sectional data analysis using the FCC penetration data to determine the economic impact of broadband on growth in jobs and state output measured as state level GDP. The research question posed is as follows: What are the effects of increasing the number of broadband lines per capita on employment growth and state GDP growth? The study's results for state GDP growth are less precise than its results for employment growth, perhaps because the federal government estimates GDP data by individual state which are less precise than state employment data (Ibid 9). Nonetheless, the authors found some empirical support for the conclusion that expanded broadband capacity led to an increase in the number of jobs and an increase in GDP, particularly in the service sector, such as finance, real estate, and educational services (Ibid 12). They estimated that an increase of 1.0% in a state's broadband penetration would yield an increase of approximately 300,000 jobs. The study also shows that the magnitude of the impact of broadband on job growth increases over time as capacity is added.

Connected Nation (2008) released an economic impact study for the entire nation that was extrapolated from an analysis it had done for Kentucky (discussed below). The job growth calculation makes use of the study results of Crandall et al. and uses average annual wages for each state in 2006, as reported by the U.S. Bureau of Labor. The study estimates that \$92 billion would be realized through the addition of 2.4 million jobs created or retained although the methodology used to capture retention was not explained. In contrast to Gillett et al. (2006) and Crandall et al. (2007), the Connected Nation study adds estimated savings from online activities involving health care, less time in cars, reduced environmental pollution, and online transactions. In short, this study attempted to address the limitations of job growth measurements by taking into account money saved through broadband users' behavior changes.

Connected Nation's projected economic impact for Kentucky applies the Crandall et al. results to job growth in Kentucky. However, that is an average nationwide estimate based on an employment mix for the entire nation and the coefficient used by Crandall et al. might not be transferable to Kentucky's particular employment profile in 2005-2007. (The Crandall et al. study was for 2003-2005). The Connected Nation's survey upon which the cost savings analysis was based relies on a sample size of less than 200 respondents for most questions. Some of the questions are also phrased in such a manner that any findings would be debatable. For example, respondents were asked: "Obtaining health care information online has empowered me to remain healthier?" The connection between online access to health care and improved health is unclear at best.⁸ And the responses came from those surveyed and not their physicians. The question: "About how much money would you estimate you have saved by becoming healthier in this way?" again suggests a connection that may not exist, and it is unclear on what basis these

⁸ For example, patients may read about treatments online that do not necessarily apply to them, and the information on Web sites may not be accurate. These were the findings of a University of Texas study on breast cancer. See "'Healthy Skepticism' Advised for Online Medical Information," *Hospital & Health Networks*, 82(3):59, March 2008. Likewise, we might expect the same problems to apply to other health conditions because there is no quality control on much of the information posted on the Internet.

savings determinations have been made because respondents apparently define the estimates and their definition of improved health.

Another economic impact study on broadband in Kentucky was conducted by Shideler et al. (2007). Like the studies by Gillett et al. (2006) and Crandall et al. (2007), this study does not deal with broadband use but rather broadband deployment and makes no distinction in broadband speeds, both caveats acknowledged by the authors. Nonetheless, the deployment data in the Shideler et al. study appear to be more granular than data collected from zip codes in the FCC's Form 477: the study relies on the aggregation of county-level data from ConnectKentucky's Geographic Information System database which consists of proprietary data from broadband providers in the state. In contrast to the other studies discussed above, the Shideler et al. study focuses solely on employment growth. However, the impact of broadband on employment growth may not be adequate to fully capture broadband's benefits because employment growth may be due to multiple factors and the factors used in this paper for measuring impact appear to have a fairly low level of explanatory power.⁹ The Shideler et al. study analyzes the impact of broadband on employment growth in various industries and finds that broadband availability contributes to employment growth in most industries to some degree. Only one industry – accommodations and food services – realized reduced employment due to broadband deployment. For example, people can make their own arrangements online for accommodations, and broadband connectivity enables technology to be used instead of employees for various accommodation- and restaurant-related service transactions. Finally, the study suggests that a certain level of broadband infrastructure is needed to significantly affect employment growth. Too much or too little broadband infrastructure saturation portends lower returns on investment. According to Shideler et al., "The policy implication is that investment in broadband infrastructure achieves its greatest return, measured by employment growth, in communities that have average saturation levels" (p. 117).

Another state-specific study by Ford and Koutsky (2005) compares the economic impact on economic growth of a municipally owned broadband system in a Florida county, Lake County, to that of comparable Florida counties without municipally owned broadband systems. Broadband services through Lake County's network were made available to businesses and government institutions. The economic growth in this context is measured by gross sales per capita. The comparison years are the three years prior to and the three years after 2001 – the year the broadband network was first used extensively throughout the county. The findings suggest that Lake County experienced 128% growth in gross sales per capita over its peers since the construction of the municipal network. Studies of this sort, no matter how well conceived, raise questions about the selection of comparable counties. For example, the economies of Florida's counties were affected differentially by a lower level of tourism and snowbird migration in the aftermath of 9-11 and by a spate of hurricanes in 2004 which devastated several

⁹ The study uses four models to estimate broadband's contributions toward total employment. This impact ranges from 0.14% to 5.32%.

counties, including Charlotte—one of the comparison counties in the study. The authors assumed that the comparison counties had some private broadband network presence and speculated that the incentives of the private sector may have been less geared to deploying broadband as extensively. Hauge, Jamison, and Gentry (2008) showed that municipalities were more likely than private operators to compete with incumbents in rural and low-income areas, but were deterred from entering where the incumbent already faced competition. The Ford and Koutsky study does not appear to account for the increase in taxes or fees in Lake County to recover the infrastructure investment.

A study prepared by the Sacramento Regional Research Institute for AT&T (Van Gaasbeck et al. 2007) analyzes the economic impact of broadband on 39 California counties from 2001 through 2006. Because these counties accounted for approximately 92% of the state population, that coverage served as a proxy for the entire state. In contrast to the nationally based studies and the Kentucky studies previously cited, the California study measures broadband use and not deployment. The data for broadband use came from a proprietary database consisting of survey results that reflected the extent to which adults accessed the Internet in their homes. To determine effects, Van Gaasbeck et al. disaggregated the 39 counties into 24 regions. They also assessed the degree of migration from dial-up connectivity to either DSL or cable during the six-year period, 2001 through 2006. In general, they found that broadband deployment appeared to contribute to employment and total payroll growth but not to an increased number of physical business establishments.¹⁰ Indeed, the broadband roll-out appeared to have had a negative impact on such growth. In contrast to the findings of the California study, Gillett et al. (2006) found that broadband contributed to a positive increase in the number of firms. Van Gaasbeck et al. speculated that the difference in findings may be due to attributes of California counties related to those of counties elsewhere: perhaps telecommuting is more prevalent in California than elsewhere; it might be more expensive to rent buildings for businesses in California than elsewhere; and the way businesses were defined to measure growth is different in the California study than in the study by Gillett et al. While not passing judgment on these hypotheses, we add another possibility for the divergent findings: the U.S. Department of Commerce study spanned an earlier period, 1998-2002, and the California study covered for the most part a later period, 2001-2006, when broadband was much more widely deployed and accessed. For example in early 2003, broadband service was used by only 23.8% of adult Californians but in the latter part of 2006, the percentage grew to 53.5%. (Van Gaasbeck et al. 2007, Figure 2.6) It seems reasonable that the impacts of broadband will change as deployment and subscription increase.

The findings of Van Ark and Inklaar (2005) support the notation that impacts change over time. The authors noted that there appears to be a time lag between broadband adoption and productivity growth; for an interval after adoption, there may even be a loss in productivity when

¹⁰ The California study (Van Gaasbeck et al.) is somewhat cautious about the negative impact on business establishment growth, noting mixed results once robustness is checked.

businesses experiment with the technology. If we assume, as was assumed in the California study, that household Internet access is indeed a good proxy for business use, it may take some time for individuals to gain sufficient technological aptitude to become more mobile in their working habits. The movement away from traditional office designs is becoming more acceptable as workers' habits change, and they find they can work from anywhere aided by new technologies (*The Economist*, "Labour Movement" 2008). This transformation in work habits could portend the need for less physical office space and very different office designs where work could be more easily mixed with other non-work activities (*The Economist*, "The New Oases" 2008). However, there are detractors to this way of thinking: *The Economist* concluded that while bandwidth is continuing to expand, the relationship between greater speeds and innovations still remains unclear (*The Economist*, "The Broadband Myth" 2008).

To summarize, we now have several studies on the economic impact of U.S. broadband but most of those studies use estimates of deployment and not subscribership and rely on data from FCC 477 filings that have not been sufficiently granular. However, despite these shortcomings, increased higher broadband penetration does appear to correspond to greater job growth and increased GDP although we still have much to learn about the specific dynamics. In a similar vein, a recent OECD report finds GDP and broadband penetration to be correlated in member countries but notes that the relationship between the two is not necessarily causal (OECD 2008b, p. 26).

PART II CHALLENGES FACING THE U.S. IN USING BROADBAND EFFECTIVELY TO MAINTAIN GLOBAL COMPETITIVE STATUS

The observation – that the way we live and work can be transformed by the use of ICT, including broadband – is a good segue to challenges facing the U.S. in its efforts to advance its global competitiveness. The primary challenge is whether the U.S. will continue on a path that is friendly to creative destruction or move to a path that is less adaptive. Current public policies toward broadband deployment and subscription favor allowing providers to make choices about broadband deployment and services offered and allowing most customers to select their service providers, technology platforms, and services. These policies leverage the knowledge and information that consumers and providers have to adapt to new services and technologies as circumstances change. There is increasing pressure to expand the role of government in deployment and subscription decisions, which could potentially bring into the new communications world the rigidities and rent seeking that in the past had characterized traditional telephony in the U.S. A secondary challenge is whether U.S. broadband policies will only relate to pipes or whether they will also embrace other dimensions of advanced communications services, such as content.

The National Policy Debate

There is some debate about whether the U.S. has a sufficiently proactive national broadband policy. For example, Atkinson 2007 contended that the U.S. policy of relying so heavily on market forces impedes the nation's competitiveness. One might argue that the U.S. broadband policy is outlined in the federal Telecommunications Act of 1996 (hereafter, the 1996 Act).¹¹ Specifically, Section 706 (b) of the 1996 Act reflects congressional intent that advanced information services (defined as broadband) be made available to all Americans through measures such as price cap regulation, regulatory forbearance, promotion of competition, and the removal of barriers to competition. Consistent with that view, Section 706 required the FCC to regularly investigate whether broadband was being "deployed to all Americans in a reasonable and timely fashion." Section 706 also required the FCC to take action if deployment failed to progress in such fashion: the FCC was directed to remove barriers to entry and promote competition. The focus of this policy is on availability, not subscription, which seems to imply that Congress intended to leave decisions about the purchase, use, and valuation of broadband services to customers. Section 706 made it clear that the U.S. strategy regarding ubiquitous broadband deployment is to be accomplished largely through competitive means without direct government subsidy, except in the case of K-12 education and rural health care.¹²

The effectiveness of competition and market mechanisms to promote the deployment and subscription of broadband is supported by empirical studies that show that more competition leads to greater investment and greater subscription than does less competition.¹³ Furthermore, several studies suggest that the essentials of open markets – freedom of choice, risk bearing, and accepting the consequences of both good and bad decisions – promote the efficiency, innovation, and adaptability that are critical to global competitiveness. In contrast, regulation of retail markets can potentially impede competition, and the regulatory process can be manipulated under certain conditions.¹⁴

¹¹ PUB. L. NO. 104-104, 110 Stat.56.

¹² Federal universal support has not been available for broadband deployment for most purposes. However, the 1996 Act authorized discounted rates (known as "E-rates") from the universal service support mechanism to accelerate broadband deployment in eligible schools, libraries, and rural health care facilities. Goolsbee and Guryan (2005) showed that the E-rates significantly increased Internet access in California public schools.

¹³ For a summary of such studies, see Jamison (2007).

¹⁴ Kahn (1998) explained how regulation of competition creates inefficiency and harms customers. Yarrow (2008) described how competitive markets are superior to regulation in leveraging the information and knowledge of customers and producers. Prieger (2002) showed that regulatory oversight of competitive information markets reduced the number of innovations by 40% to 50% compared to periods when there was no regulatory oversight. Rosston et al. (2006) demonstrated that interest groups have been able to use the regulatory process to influence telecommunications prices even after markets are open to competition. De Figueiredo and Edwards (2005) demonstrated that telecommunications providers are able to influence regulation through campaign contributions. Foreman (2003) showed that heavy involvement in the regulatory process by new entrants in local telecommunications markets was positively correlated with their failure in the marketplace.

Whereas competition may be the most desirable means of spurring investment and ultimately stimulating innovation, there is some debate over whether the market-oriented approach is providing optimal broadband deployment. For example, former FCC Chairman Kennard (2006) in an Op Ed to *The New York Times* argued that subsidies were needed because in some situations the socially desirable amount of broadband is not commercially viable in high-cost areas and low-income areas. Likewise, Atkinson (2007) argued that a market-only approach¹⁵ results in suboptimal levels of broadband deployment because customers fail to factor socially beneficial externalities into their willingness to pay for broadband, and producers fail to factor these externalities into their profit considerations. In 2007, the Federal-State Joint Board on Universal Service, which makes recommendations to the FCC on universal service issues, requested that the FCC include broadband in the list of services eligible for universal service support pursuant to Section 254 of the 1996 Act in order to redirect Universal Service Fund support to broadband use. To date, the FCC has not acted on that recommendation. In a similar vein to the Federal-State Joint Board recommendation, Benton (2008) recommended shifting federal universal service support to broadband. Currently, federal universal service support is explicitly used for telecommunications services, not broadband.¹⁶

Arguments in favor of more proactive government policies, such as those posited by Atkinson 2007, generally focus on issues of network externalities, “prosumer”¹⁷ investment externalities, competitiveness externalities,¹⁸ less broadband deployment in areas that have low-income populations or are costly to serve, and a lack of knowledge on the part of consumers about the benefits of broadband.¹⁹ We address these arguments below. The network externalities argument holds that a consumer who decides not to purchase broadband because it is not worth the price to that consumer fails to take into consideration the benefits other consumers would receive from the nonsubscribing consumer being on the broadband network. This argument appears to confuse network externalities with network effects. Positive network effects exist when network value increases as more people subscribe to the network. But as Liebowitz and Margolis (1995) explained, network effects are externalities only if market participants fail to

¹⁵ In reality, there are no “market-only” approaches as all markets in the U.S. are at least regulated by contract law, certain competition policies, and provisions of the 1996 Act, etc. Atkinson’s appeal for a more proactive national broadband policy calls for more public subsidies and production targets.

¹⁶ The FCC has defined broadband as an information service rather than a telecommunications service, apparently to accommodate the agency’s desire to forebear from regulating broadband as it would other telecommunications services.

¹⁷ Atkinson used the term “prosumer” (a word originally coined by futurist Alvin Toffler) to connote consumers who also operate as producers by taking over functions that were provided by service sector employees. Examples cited by Atkinson are self-service checkouts at grocery stores and consumers’ use of airport kiosks to print and issue boarding passes.

¹⁸ We combine Atkinson’s competitiveness externality and regional externality into a single argument because the answer to both arguments is the same.

¹⁹ See Kraemer et al. (2005), Kennard (2006), and Atkinson (2007) for summaries of the arguments in favor of greater government intervention.

internalize the network effects. Liebowitz and Margolis demonstrated, however, that network providers are generally able to do so.²⁰

“Prosumer” activities are those in which individuals engage in self-service (such as in a self-serve checkout line). As Atkinson explained, technology has evolved in such a manner that the distinction between consumers and providers is increasingly blurred. The examples of telecare and e-commerce are much like the example of self-service checkouts cited by Atkinson. The consumer is engaging in activities that would have been provided by others in a different era. In the case of telecare, a nurse might have taken the patient’s blood pressure. Now the patient might do it herself at home and submit her reports using broadband technology. In the case of e-commerce, the consumer might order a book directly from the publisher instead of buying from a retail bookseller who would have ordered the book for the consumer. In those examples, there is arguably little externality because the individual making the purchasing decision and the network provider would typically absorb all or nearly all of the costs and value of the transaction. The examples of distance learning, telemedicine, and telecommuting likewise do not involve externalities because the purchasers involved – school officials acting as agents of tax payers, medical service providers, and employees – are simply making choices about modes of operation. A school might choose broadband because it allows the school to save on hard copy publications or do things that would be otherwise unaffordable, such as let students communicate with distant instructors or other students. In the case of telemedicine, rural hospitals can obtain expertise or services that would otherwise be more costly or even unaffordable. In the case of telecommuting, an employee may be able to work more hours or keep a job even if the employee is unable to travel to the employer location. The negative effects of air pollution and dependency on foreign oil could be mitigated at least somewhat by increased telecommuting and greater reliance on telemedicine; however, these are not really the result of inadequate broadband supply or market failures for telecommunications. Rather they are energy issues and are central to the ongoing discussions of energy policy in the U.S.

The competitiveness externality is a concern that producers of ICT hardware, software, and services will develop primarily where broadband is already widely available and used. However, this is not really an externality because the factors that make an ICT-based industry possible – an educated workforce, low wage rates (in some instances), and a business-friendly regulatory and tax environment – are also the same factors that spur the development of applications in response to projected demand. The broadband capacity needed to support those applications makes investments in ICT commercially viable.

In discussing the competitiveness externality concern, Atkinson cited Asian countries that are leaders in ICT and argued that they are leaders because of their broadband infrastructure.

²⁰ Indeed, we do not agree with Atkinson’s implication that telephone universal service subsidies were needed because of positive network externalities (Ibid 6). In fact, the FCC did not adopt a policy of extensive subsidies for rural, high-cost telecommunications companies until the late 1960s and the 1970s, by which time nearly all households had telephone service. For detailed information on the establishment and progression of what have become known as universal service subsidies in the U.S., see Gabel (1967), Mueller (1993), and Jamison (2002).

However, the causality seems to be more complex than the argument allows. While it is true that networks are important for ICT-based businesses (Colombo et al. 2008), the Asian countries cited by Atkinson became leaders in ICT manufacturing before they had caught up to the U.S. in terms of telecommunications availability and use.

Another concern is that certain areas with predominantly low-income populations or populations that are costly to serve will result in insufficient demand, therefore making broadband commercially unprofitable. This may be true, but it does not follow from this observation that a subsidy policy would be beneficial. The U.S. has a long, unsatisfactory history of subsidizing telecommunications for low-income households and for areas that are considered high cost to serve. The primary low-income subsidy program called Lifeline provides price discounts on basic local telephone service. Research has consistently shown that the program has done little to improve telephone subscription by low-income consumers.²¹ The high-cost subsidy program called the High Cost Fund provides subsidies primarily to small telecommunications service providers with high costs for fixed line service. Research has consistently shown that this support has done little to make telephone service more affordable in high-cost areas and has actually distorted competition and discouraged the subsidized companies from improving efficiency.²²

Federal subsidies in the form of high-cost universal service support are available for eligible providers serving sparsely populated and remote areas in the U.S. Although these subsidies were intended for telecommunications services and not explicitly for broadband, many small rural carriers were able to invest in DSL services as part of their telecommunications deployment efforts and recover portions of those costs through the High Cost Fund. This is perhaps a good example of unintended consequences from the high-cost universal support

²¹ Garbacz and Thompson (1997, 2002, and 2003) found that due to small demand elasticities, it requires extremely large expenditures per household to promote Lifeline in order to increase the telephone penetration rate. Eriksson et al. (1998) focused on targeted versus untargeted subsidies in considering policies to promote universal service and found that untargeted subsidies such as Lifeline are ineffective. Holt and Jamison (2006) found very low participation in Lifeline in Florida and that it had little if any effect on low-income household's subscription to telephone service. Albery (1995) found that offering Lifeline had no statistically significant impact on telephone subscribership. Eriksson et al. (1998) found that low-income support had no positive effect on telephone subscriptions. Ackerberg et al. (2008) found that mandatory participation in Lifeline could increase low-income subscription to telephone service, but the analysis ignores the complexities of such a mandate that would lower its effectiveness and ignores low-income households' preferences for prepaid mobile phones (Hauge, Chiang, and Jamison 2008).

²² Rosston et al. (2006) showed that high-cost subsidies since the passage of the 1996 Act have lowered urban prices rather than rural prices. Kaserman et al. (1990) found that explicit subsidies did not lower residential prices in the U.S. Chiang, Hauge, and Jamison (2008) found that high-cost fund subsidies lower competition in areas that are net recipients of subsidies and increase competition (perhaps uneconomically) in areas that are net payers of subsidies. Kraemer et al. (2005) described the poor incentives of the high-cost fund. Wimmer and Rosston (1999) demonstrated that consumers are unlikely to benefit from expansion of current universal service subsidies and could benefit from substantial curtailments and realignment.

mechanism. Meanwhile, the much larger Regional Bell Operating Companies typically received less support per subscriber from those subsidies and, because their subsidies are based on cost models rather than their accounting costs, they are unable to fund their broadband deployments through these subsidies (Windhausen 2008).

The U.S. national broadband policy centered on market-based competition does not preclude states from adopting policies that are less market oriented. This policy has allowed states and local governments to enact legislation or adopt measures that have the effect of either impeding or promoting competitive broadband deployment. The first two examples illustrate how state and local decisions may have served to impede competition in broadband deployment: Some states authorized providers to enter into exclusive contracts with apartment owners for cable and telecommunications services until the FCC issued orders banning such contracts (FCC 2007_b and 2008_d, respectively). Local governments imposed franchise requirements on cable companies providing video programming; in exchange for the right to serve a locality, many companies were required to provide services that they considered to be onerous. The FCC subsequently preempted local governments' practice of awarding such franchise agreements, in part because they were considered a deterrent to broadband investments by potential competitors (FCC 2007_c). Meanwhile, 18 states enacted legislation to authorize statewide cable franchises; these franchises could have the effect of removing barriers to entry and promoting competition in video program delivery.

In some cases, state broadband initiatives may have even propelled federal action. For example, several states authorized mapping initiatives and data collection efforts that may have, at least in part, spurred the FCC to re-evaluate its federally prescribed data collection requirements.²³ In the absence of a federal policy for market intervention, state and local governments may continue to define their own broadband targets and develop their own strategies to meet those objectives unless federal measures are adopted to preempt them. If history is any guide, we might expect state and local broadband measures to comport with federal interests on certain occasions and to work at cross purposes with those interests on others.

Finally, a few observations about innovation may be in order because that term is associated with the economic growth literature cited above and with positive externalities used in Atkinson's arguments for increased government intervention. As we noted, innovation is arguably not a goal in itself but a means of adding value to products or processes. Investments in broadband infrastructure may or may not spur innovation. Indeed, innovation is not the opposite of regulation because protection of property rights, enforcement of contracts, and prevention of anticompetitive conduct are all important to the proper working of competitive markets. However, regulation must be carefully applied so that broadband investments are not deterred,

²³ Kentucky and Wyoming were cited in FCC 2007a, ¶36. The U.S. Congress also may have contributed to the FCC's decision to take action. Congressional committees held several hearings on the FCC's data collection activities. See Benton Foundation for a list of legislation under consideration, available at http://www.benton.org/tracking_legislation.

innovative products and processes may continue to flourish, and productivity is not undermined. According to Arnold et al. (2008), tight regulation of telecommunications services slows productivity growth. Specifically, they found that inappropriate service regulations hinder the allocation of resources toward the most dynamic and efficient firms (i.e., those regulations that distort competitive outcomes). This finding is at least somewhat consistent with FCC Chairman Keith Martin's observation in a recent interview that "he's been walking a very careful line between innovation and regulation. We need to encourage investment in infrastructure and innovation but we also need to ensure that its fruits are regulated in such a way that they remain in the consumers' best interest" (Paczkowski 2008). Regulators will undoubtedly continue to face this balancing act.

The Digital Divide in Broadband Services

References to a "digital divide" in this context could describe broadband deployment or subscribership. Although the two are related, they are not the same. Broadband deployment is a precondition for access and subscribership, although arguably deployment will not occur unless providers anticipate that demand will be adequate to justify their investments. Also, access is not necessarily the same as subscribership. For example, one may be able to access broadband services in a public library and Internet cafe but may not necessarily be a subscriber. The "digital divide" in terms of deployment usually refers to the difference between broadband service availability in more densely populated regions and more sparsely populated regions, although issues of race and income are also sometimes part of the debate.

The "digital divide" continues to be an issue for the FCC, the U.S. Congress, and the states, much as it has been for OECD countries. In the U.S., most of the action to date in bridging the divide at the federal level has been directed to health care and education.²⁴ Universal service support was authorized in the 1996 Act to assist rural health care providers through discounted rates for the installation and monthly charges of telecommunications and Internet access. The FCC also initiated in 2006 a pilot program to facilitate the establishment of a nationwide broadband network that links public and private nonprofit health care providers serving rural and urban areas and subsequently (FCC 2007_d) selected 69 applicants to participate in the program. More expansive efforts have been proposed to bridge the rural-urban broadband deployment gap affecting access to rural health services. In 2007, the Federal-State Joint Board on Universal Service proposed the use of federal high-cost universal service monies for the construction of broadband facilities in unserved areas of the nation: Funding from a "Broadband Fund," one of three proposed funds, would be allocated to states to administer the program which would take the form of grants to providers. To date, the FCC has not acted on that recommendation.

The FCC's order (2008_a) to improve broadband data collection supports the notion that more granularity in subscribership data is required to monitor whether broadband services are

²⁴ We have already discussed education, so we focus here on health care.

made available to all Americans, as articulated Section 706(b) of the 1996 Act. Because the data reported by providers to the FCC are not geographically based, we do not really know the magnitude of the urban-rural gap. We might expect the mapping efforts of several states, including Kentucky discussed above, to provide more resolution.²⁵

To better use state and local expertise, the FCC has decided to revitalize the Federal-State Joint Conference on Advanced Services (FCC 2008_e). This conference will provide a forum for exchanges between the FCC, state regulators, and local and regional parties on issues related to broadband deployment. For this and other groups, the question remains as to the best strategies for stimulating both broadband investments and demand and the need, if any, for government subsidies. In some cases, states have already determined that subsidies were needed. Such subsidies have taken the form of bond issues (Vermont and South Georgia), grants (Kentucky, Arkansas, and Utah), and state universal service support (Maine) (Holt and Galligan 2008). The subsidy issue is, of course, complicated because one never really knows, given the information asymmetry that exists between providers and government, whether investors would have actually committed funding to broadband deployment absent government support. Furthermore, as we describe above, empirical studies indicate that telecommunications subsidies in the U.S. are costly, and their positive impacts are small. There is also the possibility that wireless technologies will evolve with comparable speed to fixed broadband and thus serve as acceptable substitutes.

States providing subsidies to private providers is one approach for trying to reduce the urban-rural deployment gap. Another is for local government to partner with private providers to offer broadband services. Cities and smaller communities may decide to deploy broadband when they perceive that private providers are not deploying or upgrading broadband networks in a sufficiently timely manner. For example, Chattanooga, a small city in Tennessee, opted to fund a high-speed fiber network to provide video, high-speed Internet, and telephony to approximately 170,000 customers (Rhoads 2008). Local government efforts to fund broadband networks are often opposed by private providers on the grounds of improper use of public funding and unfair competition. To date, 20 states have restricted or banned municipalities from offering broadband or telecommunications services or regulate their deployment. Congress has failed to pass legislation to repeal those bans,²⁶ but as Hauge, Jamison, and Gentry (2008) showed, the bans are largely ineffective. Some of the municipal efforts, like the widely publicized wireless project undertaken by Earthlink in partnership with Philadelphia and a fiber initiative in Utah called Utopia, have been plagued by financial difficulties (Rhoads 2008, A12). Nonetheless, municipalities often invest in high-speed broadband especially in high-cost or low-income areas

²⁵ There may still be questions of comparability if states have different approaches to mapping and there is no federally prescribed standardization. In 2008a, The FCC sought comment on a nationwide broadband mapping initiative. See ¶¶ 34-35.

²⁶ For a list of states, see <http://www.cybertelecom.org/broadband/muni.htm>.

where private companies are not competing with incumbent local telephone companies (Hauge, Jamison, and Gentry, 2008).

Subsidies to accelerate high-speed deployment may not only be a risky proposition and of limited effectiveness, but they also ignore customer demand. For example, one broadband study observed: “While the development of broadband services started later in greater Minnesota, availability is not far behind the metro area. A more significant problem is underutilization of broadband services” (Blandin Foundation 2004, p. 10). This study used an earlier period of 2002 as the basis for concluding that the cost of broadband services to customers and the value to switch from dial-up service may have been a deterrent for greater use. Many recent state initiatives understand that demand can be stimulated and aggregated to reduce the investment risk to providers, whether these providers are private or are in public-private partnerships. Another study reached a similar conclusion to the Blandin Foundation study with respect to residential Internet use: computer ownership should be the policy priority (Stanton 2004). Once people discover the applications on the computer, they will demand more. So this study emphasizes the importance of policy intervention on the demand side, arguing that the deployment will follow. There are, however, at least two caveats with these studies: they apply to residential users and not to business users of broadband services, and they are several years old.

Regulatory Barriers

Since 1996, the FCC has attempted to remove barriers to competition, particularly barriers to the “last mile” of connectivity which is most costly for providers. For example, the FCC has deemed broadband services provided over cable modems, telephone lines, power lines, and wireless platforms to be “information services” subject to much lighter regulatory oversight than telephony. Presumably favorable regulatory treatment of broadband services would encourage investment; however, piecemeal regulation based on technology platforms has arguably slowed the pace of competition and broadband deployment in the U.S. In a recent article, Holt and Jamison (2008) used the example of the FCC’s regulation of telephony and cable to show how federal regulation in both realms has operated along two frequently incompatible trajectories. The FCC’s regulatory policies have also lagged behind technological change because of the reliance on legalistic procedures driven by definitions that are frequently outdated. The FCC’s treatment of broadband is a case in point. Despite modifications to its Form 477 reporting requirements in June 2008, the FCC still adheres to its definition of broadband as having a minimum speed of 200 kbps in one direction except for reporting purposes. Why this matters is that federal and state policy seems to gravitate toward this type of low threshold definition. For example, many states with state universal service funds covering broadband service define broadband in the context of the FCC’s definition of 200 kbps in one direction. While we acknowledge that subsidizing broadband deployment may not produce

desired outcomes, if a state's policy decision is to do so, does it make sense to subsidize broadband deployment based on a speed that is increasingly outmoded?²⁷

In the U.S., DSL and cable modems have been and continue to be the most prevalent broadband platforms. The economic impact studies to date, therefore, have focused almost entirely on broadband via these two technologies.²⁸ Another form of high-speed connectivity is mobile wireless, which is not as widespread as DSL and cable but is very rapidly growing in U.S. subscribership. As of June 30, 2007, mobile wireless accounted for roughly 13% of technologies providing Internet access (over 200 kbps in both directions) (FCC 2008c). Internet access using mobile wireless technology has essentially more than doubled within a six-month period from December 2006 to June 2007 (Ibid). Mobile wireless broadband has the attributes of ubiquity and mobility; it accommodates mobile lifestyles; it allows for a choice of devices, such as laptops, PDAs, and MP3 players; and it fosters innovative applications (WIMAX Forum 2007). WiFi networks operate on unlicensed spectrum and contribute to mobile wireless use. The OECD ranks 30 member countries for broadband penetration (per 100,000 inhabitants). According to the ranking of December 2007, the U.S. placed 15th.²⁹ One statistic not accounted for in the OECD ranking is the number of WiFi hotspots which enable people to connect to the Internet for free or for a fee while they work and travel. In the U.S., there were 63,395 WiFi hotspots as of August 4, 2008.³⁰

Despite its growing popularity, wireless technology is still not capable of the same high speeds as DSL and cable and, therefore, cannot support the same breadth of applications.³¹ Fourth-generation networks – wireless broadband networks that are capable of delivering high-speed data, voice, video, and other services – are not expected to be available for at least three years, according to Verizon and AT&T (Schatz and Kumar 2008). One of the most notable developments is a collaborative plan by Sprint Nextel and Clearwire to establish a nationwide WIMAX network using Sprint's wireless towers and wired fiber networks. The companies have filed an application with the FCC in June 2008 for the \$14.5 billion venture (Kaplan 2008).

Wireless technology may not yet be considered a replacement for more traditional broadband platforms of cable and DSL for certain applications. However, the FCC appears to acknowledge its growing importance and has taken several steps to improve that technology's competitive stance by removing barriers to entry. These measures include auctioning off 700 MHz in spectrum, with the objectives of promoting innovative wireless broadband services and

²⁷ This, too, is an argument against subsidizing broadband, namely that a government's choice of speed and technology may delay the development and adoption of more advanced technologies.

²⁸ For example, the study by Van Gaasbeck et al. (2007) on the impact of broadband on California's economy does not include migration from DSL or cable to wireless platforms or fiber-to-the-home.

²⁹ See http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html.

³⁰ See www.jiwire.com.

³¹ According to the FCC, this is true of mobile wireless broadband services, but wireless technologies using long-range directional equipment have speeds comparable to DSL and cable modems. See "What is Broadband?" available at <http://www.fcc.gov/cgb/broadband.html>.

establishing a nationwide broadband network for public safety, completing an advanced wireless service auction, including third generation (3G) wireless systems, and reassigning a portion of a mobile satellite service spectrum to facilitate broadband deployment in rural areas (FCC 2008_b).

Network Management

Video applications have transformed the Internet and have added pressure to bandwidth requirements. According to one calculation, video applications require between 100 and 1,000 times more bandwidth than their more static counterparts. The combination of video applications and more users could lead to projected traffic of more than 50 times existing capacity by 2015 (Progress & Freedom Foundation 2008). A challenge in future years in the U.S. and elsewhere will be to manage network congestion. Currently, all data transmitted over the Internet are delivered on a best-effort basis but rapidly expanding Internet traffic has placed pressure on network broadband operators to prioritize Internet traffic. Concerns over prioritization have resulted in appeals in the U.S. for greater regulation of network operators in their management and pricing of network services.

The question of whether broadband networks should be allowed to offer and charge more for priority transmission of content is central to the net neutrality debate. Some argue that allowing prioritization would benefit consumers by expediting service delivery and ensuring service quality. Others argue that network operators would amass too much power over the operation of and access to the Internet.³² Jamison and Hauge (2008) and Hermalin and Katz (2007) argued that innovation will be stimulated at the edges of the network and network providers will have an incentive to increase capacity if a premium transmission speed is offered and can be purchased at a higher price. One option is to charge more for the use of greater bandwidth. This is often referred to as the bit cap approach. Consumers who use more bandwidth by watching television and movies online and playing video games would pay more than people who use the Internet only for e-mail and occasional news. Time Warner Cable is currently experimenting with this approach in Beaumont, Texas. Customers are asked to select a monthly plan based on anticipated usage of up to 5-gigabytes, 20-gigabytes, and 40-gigabytes. They would pay more if their Internet usage causes them to exceed the selected cap (Stelter, 2008). Countries that already offer such plans are Australia, Belgium, Canada, and New Zealand (OECD 2008_b, p. 48).

Network management strategies can result in perceived conflicts of interest if the provider appears to block content that competes with its own content or if the provider's network management activities appear to single out companies for adverse treatment. The latter was the case with Comcast's temporary termination of customer connections that used file-sharing services from BitTorrent.³³ Management of network traffic will continue to be a volatile issue

³² For a discussion of these issues and congressional deliberations in the U.S., see Gilroy 2007.

³³ Following this action, the FCC held an en banc hearing on April 17, 2008 in Palo Alto, California to consider what constitutes acceptable network management practices. See <http://www.vontv.net/events/080417/>.

and any determinations by providers or regulators to set priorities on content or impose differential pricing on the volume of Internet usage will undoubtedly affect the type of content used, competitive service provision, and businesses' future plans for developing online applications. What this means for economic growth is, of course, unclear but consumer demand for certain content will undoubtedly change and content delivery will likewise change in response to evolving consumer demand.

The FCC has continued to take a very light-handed oversight approach to network management by adopting a set of four principles in August 2005 governing broadband deployment. These principles entitle consumers to

- access the lawful Internet content of their choice;
- run applications and use services of their choice, subject to the needs of law enforcement;
- connect their choice of legal devices that do not harm the network; and
- have access to competitive network providers, application and service providers, and content providers (FCC 2005).

These principles have not been incorporated into FCC regulations or into federal statutes to date but inform commission deliberations on network management-related issues. There have been questions about the enforceability of these principles and some appeals, even from commissioners, to strengthen enforcement.³⁴ One option is to develop binding nondiscrimination rules (as opposed to nonbinding principles) and another, more sweeping option is to require the functional separation of accounts for platforms and services. The implications of either course of action lie beyond the scope of this paper but would pose significant challenges to regulators, regulated companies, and other affected parties.³⁵

To conclude, each country has its unique set of institutions, case law, socio-demographic profiles, and geographical constraints that will affect broadband deployment, penetration, innovative use of broadband services, and economic growth. For example, the South Korean government was able to take a leadership role in propelling the deployment of ADSL Internet service in ways that would not be amenable to the U.S. South Korea, in contrast to the U.S., has a national policy of government intervention in broadband deployment and the stimulation of broadband demand. Its government was active in creating demand for broadband services by initiating programs to encourage buildings to provide broadband capacity, high school curricula to require competency in computer skills, and content providers to develop new products. South Korea's government also contracted for research to come up with a fee consumers would pay to access the Internet using ADSL. Its supply side efforts included: encouraging computer

³⁴ Ibid. (Re: the en banc hearing on April 17, 2008). Statement of FCC Commissioners Jonathan Adelstein and Michael J. Copps available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-281626A1.pdf and http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-281625A1.pdf, respectively.

³⁵ The implications of various network management oversight scenarios are analyzed in Bauer 2007. For a review of the U.S. experiences with functional and structural separation, see Jamison and Sichter (2008).

manufacturers to produce low-priced computers, allocating research funding for development of computer chips, and stimulating competition among ISPs (Youngbae et al. 2008). One could hardly imagine the U.S. federal government undertaking such an orchestrated, government directed effort.

The challenges currently facing the U.S. have also confronted many OECD countries. We might expect developing countries to face similar challenges although through different trajectories as their economies become increasingly dependent on ICT and broadband capacity. Regardless of strategies selected, each country will need to find the best combination of market forces and government intervention. As we have shown, the market-based approach toward deployment has served the U.S. on the whole well, but government subsidies run the risk of impeding competition and the development of new technologies which are so crucial to innovative processes and services.

Bibliography

Ackerberg, Daniel A., Michael H. Riordan, Gregory L. Rosston, and Bradley S. Wimmer. 2008. *Low-Income Demand for Local Telephone Service: Effects of Lifeline and Linkup*. Stanford University: Stanford Institute for Economic Policy Research.

Albery, Brooks. 1995. "What Level of Dialtone Penetration Constitutes 'Universal Service'?" *Telecommunications Policy*, 19(5): 365-380.

Arnold, Jens, Giuseppe Nicoletti, and Stefano Scarpetta. 2008. *Regulation, Allocative Efficiency and Productivity in OECD Countries: Industry and Firm-Level Evidence*. Paris: Organisation for Economic Co-operation and Development.

Atkinson, Robert D. June 2007. *The Case for a National Broadband Policy*. The Information and Technology and Innovation Foundation, available at <http://www.itif.org/files/CaseForNationalBroadbandPolicy.pdf>.

Atkinson, Robert D., and Daniel K. Correa. February 2007. *The 2007 State New Economy Index: Benchmarking Economic Transformation in the States*. The Information Technology and Innovation Foundation, available at http://www.itif.org/files/2007_State_New_Economy_Index_Small.pdf.

Bauer, Johannes M. 2007. "Dynamic Effects of Network Neutrality." *International Journal of Communication*, 1: 531-547, available at <http://ijoc.org/ojs/index.php/ijoc/article/viewFile/156/79>.

Benton, Charles. 2008. *The Future of Universal Service is Broadband*. Benton Foundation, June 23, 2008, available at <http://benton.org/node/14876>.

Blandin Foundation. April 2004. *Increasing Economic Vitality: A Community Guide to Broadband Development*, available at http://www.blandinfoundation.org/Broadband%20Guide/BB_Guide_Letter_webenabled_04_04_04.pdf.

Chiang, Eric P., Janice A. Hauge, and Mark A. Jamison. 2008. "Subsidies and Distorted Markets: Do Telecom Subsidies Affect Competition?" University of Florida, Department of Economics, Public Utility Research Center Working Paper, available at http://www.cba.ufl.edu/purc/purcdocs/papers/0704_Chiang_Subsidies_and_Distorted.pdf.

Colombo, Massimo G., Luca Grilli, and Cinzia Verga. 2008. "Broadband Access and Broadband-Based Applications: An Empirical Study of the Determinants of Adoption Among Italian SMEs." In *Handbook of Research on Global Diffusion of Broadband Data Transmission*, eds. Yogesh K. Dwivedi, Anastasia Papazafeiropoulou, and Jyoti Choudrie, 466-480. Hershey, Pennsylvania: Information Science Reference.

Connected Nation, Inc. February 2008. *The Economic Impact of Stimulating Broadband Nationally*, available at http://www.connectednation.org/documents/NewForPrint_2008_02_21_TheEconomicImpactofStimulatingBroadbandNationally_AConnectedNationRep.pdf.

Crandall, Robert, William Lehr, and Robert Litan. July 2007. "The Effects of Broadband Deployment on Output and Employment: A Cross-Sectional Analysis of U.S. Data." *Issues in Economic Policy*, The Brookings Institute, No. 6, 1-34, available at <http://www3.brookings.edu/views/papers/crandall/200706litan.pdf>.

De Figueiredo, Jr., Rui J. P., and Geoff Edwards. 2005. "Does Private Money Buy Public Policy? Campaign Contributions and Regulatory Outcomes in Telecommunications." University of California, Berkeley, Haas School of Business and Department of Political Science Working Paper.

The Economist. 2008. "The Broadband Myth," March 23.

The Economist. 2008. "Labour Movement: The Joys and Drawbacks of being able to Work from Anywhere," Special Reports, April 10.

The Economist. 2008. "The New Oases: Nomadism Changes Buildings, Cities, and Traffic," April 10.

Eriksson, Ross C., David L. Kaserman, and John W. Mayo. 1998. "Targeted and Untargeted Subsidy Schemes: Evidence from Postdivestiture Efforts to Promote Universal Telephone Service." *Journal of Law and Economics* 41(2): 477-502.

Federal Communications Commission. 2005. Appropriate Framework for Broadband Access to the Internet over Wireline Facilities, FCC 05-051, Policy Statement, (rel. September 23, 2005), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-151A1.pdf.

———. 2006. *Rural Health Care Support Mechanism*, WC Docket No. 02-60, *Order*, (rel. September 29), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-06-144A1.pdf.

———. 2007_a. *the Deployment of Nationwide Broadband Data to Evaluate Reasonable and Timely Deployment of Advanced Services to All Americans, Improvement of Wireless Broadband Subscriberhip Data, and Development of Data on Interconnected Voice Over Internet Protocol (VoIP) Subscriberhip*, WC Docket No. 07-38, *Notice of Proposed Rulemaking*, (rel. April 16), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-17A1.pdf.

———. 2007_b. *Exclusive Service Contracts for Provision of Video Services in Multiple Dwelling Units and Other Real Estate Developments*, MB Docket No. 07-51, *Report and Order and Further Notice of Proposed Rulemaking*, (rel. November 13), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-189A1.pdf.

———. 2007_c. *Implementation of Section 621 (a)(1) of the Cable Communications Policy Act of 1984 as amended by the Cable Television Consumer Protection and Competition Act of 1992*, MB Docket No. 05-311, *Second Report and Order*, (rel. November 6), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-190A1.pdf.

———. 2007_d. *Rural Health Care Support Mechanism*, WC Docket No. 02-60, *Order*, (rel. November 19), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-198A1.pdf.

———. 2008_a. *the Deployment of Nationwide Broadband Data to Evaluate Reasonable and Timely Deployment of Advanced Services to All Americans, Improvement of Wireless Broadband Subscriberhip Data, and Development of Data on Interconnected Voice Over Internet Protocol (VoIP) Subscriberhip*, WC Docket No. 07-38, *Report and Order and Further Notice of Proposed Rulemaking*, (rel. June 12), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-89A1.pdf.

———. 2008_b. *the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, Fifth Report*, (rel. June 12), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-88A1.pdf.

———. 2008_c. *High speed Services for Internet Access: Status as of June 30, 2007*, (rel. March), available at http://fjallfoss.fcc.gov/edocs_public/attachmatch/DOC-280906A1.pdf.

———. 2008_d. *Promotion of Competitive Networks in Local Telecommunications Markets*, WT Docket No. 99-217, *Report and Order*, (rel. March 21), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-87A1.pdf.

———. 2008_e. Statement of Commissioner Deborah Taylor Tate on her Appointment to Serve as Federal Chair of the Federal-State Joint Conference on Advanced Services (March 19), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280922A1.pdf.

Federal-State Joint Board on Universal Service. 2007. *High-Cost Universal Service Support, Recommended Decision*, WC Docket No. 05-337, (rel. November 20), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07J-4A1.pdf.

Ford, George S., and Thomas M. Koutsy. 2005. “Broadband and Economic Development: A Municipal Case Study from Florida.” *Applied Economic Studies*, 1-15. See also Ford, George S and Thomas M. Koutsy. 2005. “Broadband and Economic Development: A Municipal Case Study from Florida,” *Review of Urban and Regional Development Studies*, 17(3): 216-229.

Ford, George S., Thomas M. Koutsy, and Lawrence J. Spiwak. November 2007. *The Demographic and Economic Drivers of Broadband Adoption in the United States*, Phoenix Center for Advanced Legal & Economic Public Policy Studies, available at <http://www.phoenix-center.org/pcpp/PCPP29Final.pdf>.

Forman, Chris, Avi Goldfarb, and Shane Greenstein. 2005. “Geographic Location and Diffusion of Internet Technology.” *Electronic Commerce Research and Applications*, 4(1): 1-13.

Foreman, R. Dean. 2003. “A Logistic Analysis of Bankruptcy within the U.S. Local Telecommunications Industry.” *Journal of Economics and Business*, 55(2): 135-166.

Gabel, Richard. (1967). *Development of Separations Principles in the Telephone Industry*. East Lansing: Michigan State University Institute of Public Utilities.

Garbacz, Christopher, and Herbert G. Thompson, Jr. 1997. “Assessing the Impact of FCC Lifeline and Linkup Programs on Telephone Penetration.” *Journal of Regulatory Economics*, 11 (1): 67-78.

Garbacz, Christopher, and Herbert G. Thompson, Jr. 2002. “Estimating Telephone Demand with State Decennial Census Data from 1970 – 1990.” *Journal of Regulatory Economics*, 21(3): 317-329.

Garbacz, Christopher, and Herbert G. Thompson, Jr. 2003. “Estimating Telephone Demand with State Decennial Census Data from 1970 – 1990: Update with 2000 Data.” *Journal of Regulatory Economics*, 24(3): 373-378.

Gillett, Sharon, William H. Lehr, Carlos Osorio, Marvin Sirbu. February 2006. *Measuring Broadband's Economic Impact*. Final report, Prepared for the U.S. Department of Commerce, Economic Development Administration, available at http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs2006/mitcmubbimpactreport_2.epdf/v1/mitcmubbimpactreport.pdf.

Gilroy, Angela, *Net Neutrality: Background and Issues*, CRS Report for Congress, Congressional Research Service, Updated December 20, 2007, available at <http://fas.org/sgp/crs/misc/RS22444.pdf>.

Goolsbee, Austan, and Jonathan Guryan. 2006. "The Impact of Internet Subsidies in Public Schools." *The Review of Economics and Statistics*, 88(2): 336-347, available at <http://www.mitpressjournals.org/doi/abs/10.1162/rest.88.2.336>.

Hauge, Janice A., Eric P. Chiang, and Mark A. Jamison. 2008. "Whose Call is It? Targeting Universal Service to Low-income Households' Telecommunications Preferences." University of Florida, Department of Economics, Public Utility Research Center Working Paper, available at http://www.cba.ufl.edu/purc/puredocs/papers/0805_Hauge_Whose_Call_is.pdf

Hauge, Janice A., Mark A. Jamison, and Richard J. Gentry. 2008. "Bureaucrats as Entrepreneurs: Do Municipal Telecom Providers Hinder Private Entrepreneurs?" *Information Economics and Policy*, 20(1):89-102.

Hempell, Thomas. 2002. "What's Spurious, What's Real? Measuring the Productivity Impacts of ICT at the Firm-level." ZEW Discussion Paper 02-42, Mannheim Germany.

Hermalin, Benjamin E., and Michael L. Katz. 2007. "The Economics of Product-Line Restrictions with an Application to the Network Neutrality Debate." *Information Economics and Policy*, 19(2): 215-248.

Holt, Lynne, and Mary Galligan. (Forthcoming). "State and Federal Policies to Accelerate Broadband Deployment in Sparsely Populated Areas in the United States: Why the Old Shoe Size Might No Longer Fit." *CommLaw Conspectus: Journal of Communications Law and Policy*.

Holt, Lynne, and Mark A. Jamison. 2006. "Making Telephone Service Affordable for Low-Income Households: An Analysis of Lifeline and Link-Up Telephone Programs in Florida." University of Florida, Department of Economics, Public Utility Research Center Working Paper, available at http://www.cba.ufl.edu/purc/puredocs/papers/0605_Holt_Make_Telephone_Service.pdf.

Holt, Lynne, and Mark Jamison. 2008. "Federal Regulation and Competitive Access to Multiple-Unit Premises: More Choice in Communications Services?" *Journal on Telecommunications and High Technology Law*, 6(2): 425-454.

Information and Communications in Japan. 2007. *White Paper*, Ministry of Internal Affairs and Communications, Japan, Ch. 1, 2007.

Jamison, Mark A. 2002. "The Role of Costing as a Ratemaking Tool in an Environment of Dynamic Change." In *The Institutional Approach to Public Utilities Regulation*, ed. Edythe Miller, and Warren J. Samuels, 250-75. East Lansing: Michigan State University Press.

Jamison, Mark A. 2007. "The 1st Academic Conference on the Auspicious Occasion of His Majesty the King's 80th Birthday Anniversary: The Importance of Telecommunications Development." In *NTC Annual Review 2007 Vol. 1*, 58-87. Bangkok: National Telecommunications Commission of Thailand.

Jamison, Mark, and Janice Hauge. 2007. "Getting What You Pay For: Analyzing the Net Neutrality Debate." University of Florida, Department of Economics, Public Utility Research Center Working Paper, available at http://www.cba.ufl.edu/purc/purcdocs/papers/0705_Jamison_Getting_What_You.pdf.

Jamison, Mark A., and James Sichter. 2008. "U.S. Experiences with Business Separation in Telecommunications." University of Florida, Department of Economics, Public Utility Research Center Working Paper, available at http://www.cba.ufl.edu/purc/purcdocs/papers/0809_Jamison_US_Experiences_with.pdf.

Kahn, Alfred E. 1998. *Letting Go: Deregulating the Process of Deregulation*. East Lansing, Michigan: The Institute of Public Utilities and Network Industries.

Kaplan, Peter. 2008. *Sprint, Clearwire Vow 'Third Pipe' Broadband Option*. June 9, 2008, available at <http://www.reuters.com/article/marketsNews/idUSN0928868520080609>.

Kaserman, David, L. Mayo, John W., and Flynn, Joseph. 1990. "Cross-Subsidization in Telecommunications: Beyond the Universal Service Fairy Tale." *Journal of Regulatory Economics*, 2(3): 231-249.

Kennard, William E. 2006. "Spreading the Broadband Revolution." *The New York Times*. October 21, 2006, Section A, Column 1, Editorial Desk, p. 13.

Kraemer, Joseph S., Richard O. Levine, and Randolph J. May 2005. *The Myths and Realities of Universal Service: Revisiting the Justification for the Current Subsidy Structure*. Progress and Freedom Foundation, Washington, D.C.

Liebowitz, S. J., and Stephen E. Margolis. 1995. "Are Network Externalities a New Source of Market Failure?" *Research in Law and Economics*, 17: 1-22.

Mueller, M. 1993. "Universal Service in Telephone History: A Reconstruction." *Telecommunications Policy*, 17(5): 352–369.

Organisation for Economic Cooperation and Development. 2008 a. *Measuring the Impacts of ICT Using Official Statistics, Working Party on Indicators for the Information Society*, available at <http://www.oecd.org/dataoecd/43/25/39869939.pdf>.

———. 2008 b. *Broadband Growth and Policies in OECD Countries*, available at http://www.oecd.org/document/1/0,3343,en_2649_34223_40931201_1_1_1_1,00.html.

Osorio-Urzuá, Carlos. 2008. "The Missing Link: Why does ICT Matter for Innovation? Exploring the Effect of Information Technology on Innovation-Based Competitiveness." *Global Information Technology Report 2007-2008*, World Economic Forum, 2008, 39-56.

Paczkowski, John. May 2008. "Net Neutrality and Open Access: FCC Chairman Kevin Martin & Verizon Wireless CEO Lowell McAdam." *All Things Digital*, available at <http://d6.allthingsd.com/20080529/martin/>.

Prieger, James E. 2002. "Regulation, Innovation, and the Introduction of New Telecommunications Services." *The Review of Economics and Statistics*, 84(4): 704-715.

Progress & Freedom Foundation. 2008. *Comments before the Federal Communications Commission in the matter of Broadband Industry Practices*, WC Docket No, 07-52, February 13, 2008, available at <http://www.pff.org/issues-pubs/filings/2008/080213NetworkManagementFCCFiling.pdf>.

Rhoads, Christopher. 2008. "Cities Start Own Efforts to Speed Up Broadband." *The Wall Street Journal*. May 19, 2008, A-1, A-12.

Röller, Lars-Hendrik, and Leonard Waverman. 2001. "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach." *The American Economic Review*, 91(4): 909-23.

Rosston, Gregory L., Scott J. Savage, and Bradley S. Wimmer. 2006. *The Impact of 'Deregulation' on Regulator Behavior: An Empirical Analysis of the Telecommunications Act of 1996*. Stanford University: Stanford Institute for Economic Policy Research.

Rowe, Jonathan. 2008. "Our Phony Economy." *Harper's*. June 2008, 17-24.

Schatz, Amy, and Vishesh Kumar. 2008. "Corporate News: Wireless Giants' Ambitious Airwave Plans; Verizon and AT&T, FCC's Big Winners, Bank on Innovation." *The Wall Street Journal*. April 4, 2008, B. 4.

Schwab, Klaus, and Michael Porter. 2007. *The Global Competitiveness Report 2007-2008*. Geneva, Switzerland: World Economic Forum.

Shideler, David, Narine Badasyan, and Laura Taylor. 2007. "The Economic Impact of Broadband Deployment in Kentucky." Federal Reserve Bank of St. Louis, *Regional Economic Development*, 3(2): 88- 118, available at <http://research.stlouisfed.org/publications/red/2007/02/Shideler.pdf>.

Stanton, Laura. 2004. "Factors Influencing the Adoption of Residential Broadband Connections to the Internet." *Proceedings of the 37th Hawaii International Conference on System Sciences – 2004*, available at <http://csdl2.computer.org/comp/proceedings/hicss/2004/2056/05/205650128a.pdf>.

Stelter, Brian. 2008. "Charging by the Byte to Curb Internet Traffic." *The New York Times*. June 15, 2008.

2010 High Level Group. April 2006. Information Space Innovation & Investment in R&D Inclusion. *The Economic Impact of ICTs: Evidence and Questions*, available at http://ec.europa.eu/information_society/eeurope/i2010/docs/high_level_group/note_on_economic_impact_of_ict.pdf.

U.S. Department of Commerce. Bureau of Economic Analysis. January 2008. *Private Services-Producing Sector Continued to Lead Growth in 2006: Revised Statistics of Gross Domestic Product by Industry, 2004-2006*, available at <http://www.bea.gov/newsreleases/industry/gdpindustry/gdpindnewsrelease.htm>.

U.S. Government Accountability Office. May 2006. *Telecommunications: Broadband Deployment Is Extensive Throughout the United States, but It Is Difficult to Access the Extent of Broadband Deployment Gaps in Rural Areas*, GAO-06-426, available at <http://www.gao.gov/new.items/d06426.pdf>.

Van Ark, Bart, and Robert Inklaar. September 2005. "Catching Up or Getting Stuck? Europe's Troubles to Exploit ICT's Productivity Potential." Groningen Growth and Development Centre, University of Groningen, available at <http://ggdc.eldoc.ub.rug.nl/FILES/root/WorkPap/2005/GD-79/gd79online.pdf>.

Van Gaasbeck, Kristin, Stephen Perez, Ryan Sharp, Helen Schaubmayer, Angela Owens, and Lindsay Cox. December 2007. *Economic Effects of Increased Broadband in California, Research Report*. Sacramento Regional Research Institute. Prepared for AT&T.

WIMAX Forum. 2007. *Empowering Mobile Broadband: The Role of Regulation in Bringing Mobile Broadband to the Mass Market*, March 2007, available at http://www.wimaxforum.org/technology/downloads/Empowering_Mobile_Broadband_March_2007.pdf.

Wimmer, Bradley S., and Gregory L. Rosston. 1999. *Winners and Losers from the Universal Service Subsidy Battle*. Stanford University: Stanford Institute for Economic Policy Research.

Windhausen Jr., John. 2008. *A Blueprint for Big Broadband*. An EduCause White Paper, January 2008, available at <http://net.educause.edu/ir/library/pdf/EPO0801.pdf>.

Yarrow, George. 2008. "What Do Today's Regulators and Regulatees Need to Know?" Presentation at the ACCC Regulatory Conference, Gold Coast, Australia, available at <http://www.accc.gov.au/content/index.phtml/itemId/836179>.

Youngbae Kim, Hoel Jeon, and Soonhoon Bae. 2008. "Innovation Patterns and Policy Implications of ADSL Penetration in Korea: A Case Study." *Telecommunications Policy*, 32(5): 307-325.