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Summary:

Chattanooga, Tennessee; Retail Electric

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Summary:

Chattanooga, Tennessee; Retail Electric

Credit Profile		
Chattanooga retail elec		
Long Term Rating	AA+/Stable	Upgraded
Chattanooga (Chattanooga Elec Pwr Brd)		
Unenhanced Rating	AA+(SPUR)/Stable	Upgraded

Many issues are enhanced by bond insurance.

Rationale

Standard & Poor's Ratings Services has raised its rating on the City of Chattanooga (EPB), Tenn.'s electric system revenue bonds to 'AA+' from 'AA'. The outlook is stable.

At fiscal year-end 2012 (June 30), the utility had $287.5 million of debt outstanding. A net revenue pledge of the electric system secures the bonds.

The higher rating reflects both our assessment of the utility's strong credit metrics in fiscal 2012 and our view that the stronger metrics are sustainable, based on our opinion that management's forecast assumptions are reasonable.

In 2008, EPB issued $220 million of revenue bonds, of which $169 million funded the completion of a fiber optic network. Initially, the fiber network was to be for infrastructure interconnectivity purposes, which allows for more automation, demand-side management, and operating savings. Now, the network also provides Internet, phone, and video service. The utility received a federal grant to extend the system to all customers, allowing a faster build-out than originally projected.

Management believes that the fiber optic network will enhance EPB's credit profile. In August 2012, the fiber optics system established a stand-alone line of credit to repay the last of the debt borrowed from the electric system and is now covering all costs from telephone, video, and internet revenue, as well as providing significant financial benefit to the electric system. At the same time, the system is providing reliable information to the electric utility on outages, losses, and usage, which helps reduce the electric system's costs.

The rating on the electric utility incorporates other factors that we believe will help EPB maintain its strong financial risk profile. These include:

- The city's role as a regional economic center for a six-county area in southern Tennessee, as well as a three-county area in northern Georgia, and Chattanooga's ability to attract new business;
- The ability to pass through the cost of power from the Tennessee Valley Authority (TVA) and the TVA's fairly low-cost wholesale power rates; and
- The utility board's willingness to raise rates as needed to provide strong adequate debt service coverage (DSC) and

liquidity.

The business risk profile score of '3' on Standard & Poor's scale from '1' to '10', with '1' being the highest score, reflects our assessment of EPB's:

- Proactive and experienced management team and board;
- Low-cost operations; and
- Generally competitive rates.

The utility provides service to about 168,400 customers in Chattanooga (general obligation debt rating: AA+/Stable) and the surrounding area. The large commercial and industrial customer base (55% of fiscal 2012 sales and 50% of gross revenues) dominates sales and revenues somewhat. However, there is no revenue dependency upon any of the principal customers. The 10 leading customers account for just 8.6% of total revenues and 5.2% of net margins. In addition, EPB serves these customers at modest margins, further mitigating concern should open access ever become a reality within the TVA service territory. System loads continue to reflect the diversification away from a large commercial customer base. The utility benefits from federal provisions that prohibit retail wheeling to customers of TVA distributors and allows only limited direct service by the authority to large-load customers, of which there are none in EPB's service area. Management believes that the expected customer growth associated with Volkswagen AG's new manufacturing facility and Amazon.com Inc.'s distribution center will improve the financial metrics of both the electric utility and the communications business.

Despite the lack of wholesale customer choice or retail deregulation within TVA's service territory, EPB continues to focus on improving efficiencies and engaging in competitive self-assessments. Average system rate revenue is competitive, at 9.34 cents per kilowatt-hour in 2012. Aside from base-rate and fuel-cost adjustments from TVA, passed through automatically to its retail customer base, EPB has had only three modest base-rate adjustments since 1992, the last being in July 2011, in large part because of its high degree of streamlined, automated operations.

The system's financial performance has consistently been solid, in our view, providing ample capacity to incur the additional debt issued to fund the interactive fiber optic system. Historically, EPB has relied on funding capital improvements from its annual budget, with only periodic use of debt, and management currently expects to fund its five-year capital improvement program of about $40 million per year from revenue.

For fiscal 2012, annual DSC after transfers to Chattanooga's general government, was 3.3x and management expects that DSC, after transfers to the city, will be about 2.8x in the next five years, even without rate increases. We believe this level of coverage supports the higher rating. The dip in coverage in 2011 was due to the increased costs associated with the series of tornadoes that came through Chattanooga that year.

In our opinion, management maintains adequate liquidity for a utility that passes power costs directly to its retail customers monthly. Cash on hand equaled about 60 days of operating expense in fiscal 2012, and management expects it will be about 80 days in the forecast for 2013-2017. In addition, EPB has a $50 million line to cover purchased power.

Outlook

The stable outlook reflects our expectation that EPB will continue to benefit from its role as a distributor inside the TVA fence, allowing it to maintain its solid financial performance, strong levels of system equity, competitive rates, and overall financial and operational stability as its regional economy continues to deepen and diversify. We do not expect to raise or lower the rating in the next two years.

Related Criteria And Research

USPF Criteria: Electric Utility Ratings, June 15, 2007

Complete ratings information is available to subscribers of RatingsDirect on the Global Credit Portal at www.globalcreditportal.com. All ratings affected by this rating action can be found on Standard & Poor's public Web site at www.standardandpoors.com. Use the Ratings search box located in the left column.

The Impact of Broadband in Hamilton County, TN

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The Impact of Broadband in Hamilton County, TN

Executive Summary

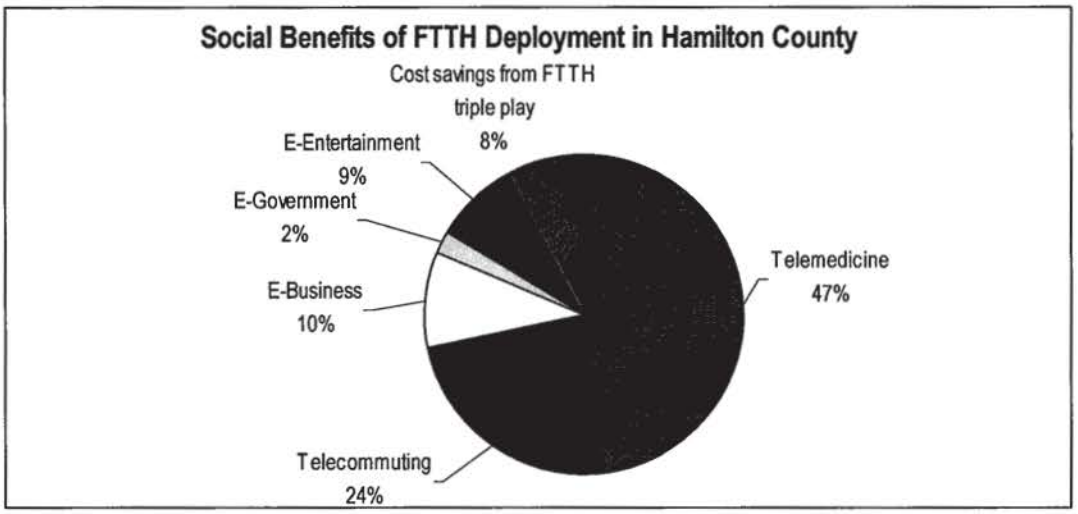
Broadband telecommunications is a critical public infrastructure required for the vitality and economic development of communities. A common misconception stemming from the use of current (first) generation cable/ADSL broadband is that it only applies to internet connections. Omitted from many commonly used definitions of broadband are such characteristics as upstream speed, symmetric capabilities and the ability to support many applications and user devices simultaneously. In fact, broadband is a continuum that ranges from DSL services that run 4.5 times faster than a dial-up modem to Gigabit services that are 17,857 times faster than a dial-up modem. Next-generation or second-generation broadband (SGB), capable of supporting video, voice and data services simultaneously over a single physical infrastructure, can provide users not merely faster internet connectivity, but a whole array of applications and communication services. These applications are likely to be the true drivers of future economic and technological growth. This second-generation of broadband is mostly associated with fiber-to-the-home (FTTH) technology.

This study seeks to provide an approach to quantifying the economic effects of current first generation broadband availability in Hamilton County, and further to gauge the potential incremental economic and social effects of second-generation FTTH deployment in the county.

It bears noting that broadband is an enabler, and as such the effects of broadband technology are felt in conjunction with other information and communication technologies, as well as with associated organizational and social changes. As a consequence, the impacts are difficult to measure and quantify, especially for individual communities. The approach taken in this paper builds on limited research in the area of broadband impacts. Philosophically, our approach is not much different from studies dealing with the impact of airports, educational institutions, roads and other infrastructure projects. Certain economic impacts are measurable based on complex input-output models for regional economies. Other economic and social impacts can be estimated based on reasonable assumptions.

We find that broadband expenditures over the period 2001-2005 supported 548 jobs and contributed $109.8 million in income and taxes to Hamilton County. Further, we estimate that a new SGB-FTTH project would cost $195.5 million over a ten year period, or $167 million in present value terms. The benefits of such a project are expected to be both economic and social. The

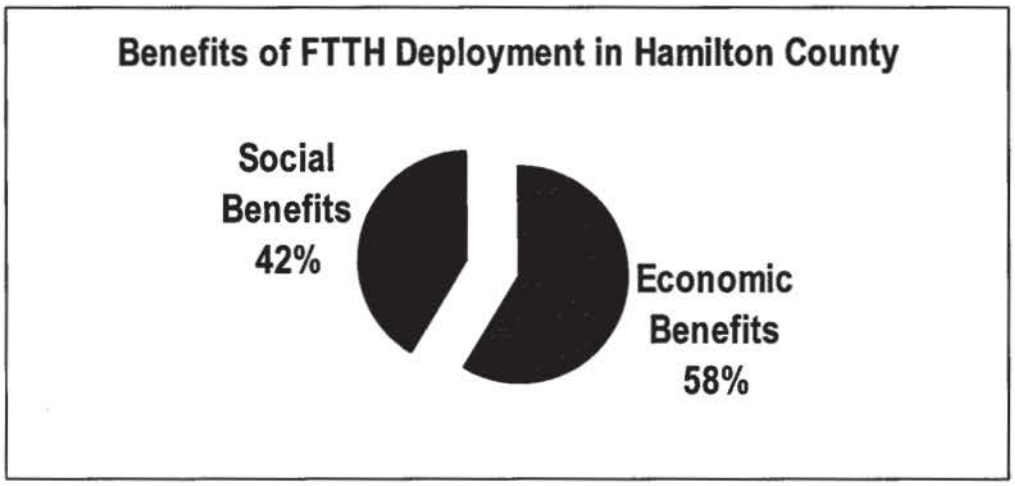
economic benefits stem from the multiplier effects of the new investment. The social benefits, estimated indirectly (and non-exhaustively), are based on select sectors of the economy that are predicted to be most impacted by SGB applications. A breakdown of these benefits looks as follows:



Our overall findings are summarized below:

Summary of Costs & Benefits to Hamilton County from SGB-FTTH Deployment	
Present Value of Economic Benefits ($ mil)	$352.4
Present Value of Social Benefits ($ mil)	$252.5
Total Economic & Social Benefits ($ mil)	$604.9
Present Value of Project Capital Expenditures ($ mil)	$167.1
NET INCREMENTAL BENEFIT TO HAMILTON COUNTY	$437.8 million + 2,638 new jobs

We find that for Hamilton County, the economic and social benefits exceed the estimated project cost by a margin of 3.6-to-1. Moreover, more than 2,600 new jobs are expected to be created in the county as a result. The indirect social benefits or positive externalities, conservatively estimated at $252.5 million, account for 42 percent of the total benefits to the county. Moreover, the project is expected to generate net incremental benefits (i.e. benefits in excess of costs) of $1,411 per Hamilton County resident over a ten-year period.



A major challenge to the deployment of SGB infrastructure in Hamilton County pertains to consumer demand for upstream applications that are not as yet widely known about. A successful SGB deployment, it would seem, would depend critically on informing and educating the public about the nature, scope and utility of upstream applications, and the resultant productivity and cost savings.

Second generation broadband must come to communities like Hamilton County if the U.S. is to compete globally. Much of the national policy debate centers on the appropriate means to realize the potential benefits from broadband. In particular, a debate rages on concerning the role of local governments in providing broadband to smaller communities. This issue becomes especially important because, as our research has shown, a large part of the benefits of SGB deployment are indirect or social in nature. These positive externalities are unlikely to be considered by private providers when making FTTH deployment decisions. Consequently, such SGB infrastructure and services are likely to be under-produced in communities under normal market conditions. However, heterogeneous economic and social factors in different communities make the role for municipal involvement in telecommunications ambiguous.

Hamilton County would benefit from the adoption of this technology sooner rather than later. The benefits are real and measurable to a large extent. Like standard public infrastructure such as good roads, schools, and hospitals, cutting-edge broadband infrastructure is crucial to economic development and to the quality of life in the county.

I. Introduction

In our day and time, broadband telecommunications is a critical public infrastructure required for the vitality and economic development of communities. Just as good schools, roads and healthcare are critical to the well-being of communities, so too is powerful communication and telecommunication technologies. President George W. Bush acknowledged this reality when he set a deadline of 2007 to achieve universal, affordable access to broadband technology for all Americans.[1] However, the International Telecommunication Union (ITU) reports that the United States fell further behind in broadband penetration in 2004, dropping to 16th in the world from 13th the previous year and 11th the year before.[2] It seems increasingly likely that the national broadband goals for the U.S. will not be met by 2007.

The relatively slower broadband deployment rate in the U.S. has spurred a debate regarding whether markets or direct government interventions would most effectively promote broadband growth (Lehr et al, 2005).[3] Lenard (2004), Rizzuto and Wirth (1998) and others argue that without economic preferences such as tax exemptions and economic subsidies, the municipal entities would contribute to inferior economic outcomes for citizens (e.g. higher electricity bills and higher local taxes). Proponents of municipal entry into broadband cite market failure stemming from the inability on the part of private providers to capture all of the economic benefits of broadband deployment. Much of this debate, it would seem, revolves around the size of the externalities accruing from broadband deployment.

This paper has three objectives: 1) to quantify the economic effects of current broadband availability in Hamilton County, a mid-sized community of about 310,000, comprising about 125,000 households and 16,000 business establishments in the southeastern U.S. state of Tennessee; 2) to quantify the incremental direct and indirect benefits (or externalities) of "next generation" or "second-generation" broadband

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[1] Report from the White House on American innovation (April 2004). Available at: http://www.whitehouse.gov/infocus/technology/economic_policy200404/innovation.pdf

[2] Total U.S. broadband penetration increased in absolute terms during the past year. But the figures for most other countries increased by far greater percentages. The global leader is South Korea, with a current penetration rate of 24.9 (See: http://www.telecomweb.com/news/1114631423.htm).

[3] The diffusion rate of broadband during the first few years since its introduction in 1995 was higher than that of color television, VCRs, mobile phones, or CD players. However, it was slightly below the initial diffusion rate of PCs and significantly below that of black and white television (Bauer et al, 2003).

associated with fiber-to-the-home (FTTH) technology in the county by exploring the economic effects of new services provided by broadband connectivity; and 3) to guide public policy on whether markets or direct local government intervention would most effectively serve the community by examining the community/social return on investment from FTTH deployment in the county.

There is no commonly agreed on definition of broadband. The term "broadband" is commonly understood to mean high (downstream) speed access to the internet in the form of Asymmetric Digital Subscriber Lines (ADSL), cable modems, and various wireless services. It is contrasted with narrowband dial-up modem access to the internet. The FCC defines a high-speed ("broadband") line to be one with a speed exceeding 200 kilobits per second (kbps) in at least one direction, while an advanced services line is a high speed line with at least a 200kbps rate in both directions. This always-on, faster-than-dialup access to the internet is a relatively recent phenomenon in the U.S., with the first commercial deployment of broadband appearing as recently as the mid-1990s.[4] By 2004, about one-third of U.S. households subscribed to broadband. In this study, we refer to the ADSL/Cable modem-provided broadband services as first-generation broadband (FGB).

Broadband, in fact, is a continuum that ranges from DSL services that run 4.5 times faster than a dial-up modem to gigabit services that are 17,857 times faster than a dial-up modem.[5] A common misconception stemming from the use of FGB is that it only applies to internet connections. Omitted from many commonly used definitions of broadband are such characteristics as upstream speed, symmetric capabilities and the ability to support many applications and user devices simultaneously. However, "next-generation" or "true" broadband, capable of supporting video, voice and data services simultaneously over a single physical infrastructure, can provide users not merely faster internet connectivity (e.g. high-speed email, web-surfing, music downloads and games), but a whole array of applications and communication services. This generation of broadband is associated with fiber-to-the-home (FTTH) technology. In this study, we use the term second-generation broadband (SGB) when referring to FTTH technology

[4] Cable modem was introduced in 1995 and DSL in 1997.
[5] Render, Vanderslice & Associates, LLC (2005)

delivering high speed voice/video/data services that provide symmetric data streams of greater than 10 Mbps and that are capable of supporting multi-user, multi-device applications.[6]

Research shows that public infrastructure investment is a powerful driver of business productivity, economic development and improvements to the quality of life. SGB reduces the disadvantages of low population density and physical remoteness from cities. It has the capacity to shrink the Digital Divide. It has the capacity to significantly improve the quality of life. A 2003 study by the Telecommunications Industry Association reports that the current first generation broadband technologies do not meet the high bandwidth requirements for emerging applications that combine voice, video and data associated with SGB usage. Such SGB applications have implications for telemedicine, telecommuting, e-government, agriculture, distance learning, public safety and national security, tourism, e-commerce, and entertainment. Additionally, SGB could stimulate applications for people with disabilities, for information gathering, small business assistance and utility applications.[7] These applications are the true drivers of future economic and technological growth.

Crandall and Jackson (2001) point out that the potential consumer benefit from universal diffusion of broadband in the U.S. could top $500 billion. A recent study by Lehr, Osorio, Gillett and Sirbu (2005) also supports the view that broadband access enhances economic growth and performance. They find that communities in which mass-market broadband was available by December 1999 experienced more rapid growth in employment, the number of businesses overall, and businesses in IT-intensive sectors. In addition, they found that broadband availability results in higher market rates for rental housing in 2000. They conclude that the economic impacts of broadband are both real and measurable.

Much of the research on broadband impacts is very recent. Most of these studies typically deal with national or state level effects (e.g. Crandall and Jackson (2001), Lehr et al (2005) and citations therein). This is because of the relative novelty of the technology and data limitations. Ford and Koutsky (2005) say it best: "One difficulty …

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[6] Allen Consulting Group (2003)

[7] The Economic and Social Benefits of Broadband Deployment, October 2003, The Telecommunications Industry Association. Available at: http://www.tiaonline.org/policy/broadband/Broadbandpaperoct03.pdf

is the general lack of sufficient economic and demographic data to analyze changes in a community's economic fortunes. Broadband service is a relatively recent phenomenon, and local economic data is often not collected on a regular basis for a detailed econometric analysis." Lehr et al (2005) indicate that data distinguishing localities by their actual use of broadband is generally not available. The FCC compiles data that distinguishes communities by broadband availability, but provides data on broadband adoption and usage only down to the state level. These studies offer useful econometric benchmark estimates but suffer from too much aggregation to be of value to individual communities.

Another strand of the literature reports on the broadband experiences of individual communities. A non-exhaustive list includes case studies on Cedar Falls and Muscatine (IO), Lake County (FL), Philadelphia (PA), Corpus Christi (TX), Chaska (MN), Greene County (NC) and Scottsburg (IN), Glenwood Springs and Lakewood (CO), and Lagrange (GA), among others. This strand of the literature can potentially be more useful to individual communities evaluating broadband choices.

The empirical research on private provider versus local government broadband deployment is limited. Ford and Koutsky (2005) explore whether direct municipal investment in broadband infrastructure creates positive economic gains for the community as a whole by studying Lake County (FL).[8] They compare economic growth in Lake County with other similar Florida counties during the period Jan-1998 to Nov-2004. They find that Lake County has experienced approximately 100 percent greater per capita growth in retail sales relative to comparable Florida counties since making its municipal network generally available to businesses in the county in 2001.

Hauge, Jamison and Gentry (2005) compare the types of markets that municipally-owned telecommunications providers in the U.S. serve to the types of markets that competitive local exchange carriers (CLEC) serve. They compile a dataset of all CLEC and municipal providers in the U.S. telecom market from 1998-2002. Using probit and logit models they conclude that municipal and private entities make market choice decisions differently. While the private entity is driven by the profit motive, the

[8] Lake County is a small, central Florida county of nearly 250,000 residents and 953 square miles which began offering private businesses access to municipally-owned broadband networks, with fiber optic connections to hospitals, doctor offices, private businesses, and 44 schools.

municipal appears to be driven by public interest. They find that the presence of a municipal provider in a market does not affect the probability that a CLEC also serves that market. Municipal participation does not preclude CLEC participation, although the reverse may be true.

This paper focuses on the current and future economic impact of first- and second-generation broadband availability in Hamilton County (TN). Located in the southeastern U.S. state of Tennessee, Hamilton County is the fourth largest county in the state with a population of 310,232. The principal city in the county is Chattanooga. In 2004, the Financial Times referred to Chattanooga as being "on the verge of a high-tech breakthrough", in describing the city's revival over the past two decades. The article goes on to attribute the city's success to city leaders, public-private partnerships and an activist citizenry.[9] The county and the Chattanooga Metropolitan Statistical Area (MSA) consists largely of businesses in the health and financial services, retail trade, and construction sectors.[10] As Table 1 indicates, almost 47 percent of county sales revenue comes from the finance/insurance/real estate sector. The most jobs are created in the services sector, and nearly 40 percent of the county sales revenue from this sector is attributable to health services.

Table 1. Hamilton County Businesses & Employment

Business type	Number	%	Employment	%	Sales Rev. ($ mil)*
Services	6,572	41.4	56,493	34.0	$3,208.2
Retail Trade	3,064	19.3	27,493	16.5	$1,965.9
Construction	1,409	8.9	9,235	5.6	$1,599.5
Finance/Insurance/Real Estate	1,327	8.4	11,878	7.1	$14,258.6
Wholesale trade	859	5.4	8,734	5.3	$1,839.9
Manufacturing	809	5.1	25,991	15.6	$4,307.0
Transportation/Public Utilities	608	3.8	14,731	8.9	$3,281.0
Agriculture, forestry & fishing	317	2.0	1,141	0.7	$44.1
Public Administration	307	1.9	10,215	6.2	$0.0
Non-classified establishments	585	3.7	65	0.0	$2.9
Mining	12	0.1	169	0.1	$2.2
TOTAL	15,869	100	166,145	100	$30,509.4

Source: Chattanooga Area Chamber of Commerce and Dun & Bradstreet Zapdata (August 2005)
*As of January 2006

[9] http://www.chattanooga-chamber.com/GetToKnowUs/americastalking.asp
[10] The Chattanooga MSA consists of Hamilton, Marion and Sequatchie counties in Tennessee and Catoosa, Dade and Walker counties in Georgia.

The rest of this paper is laid out as follows: in section II, we contrast the different types of broadband, and highlight some of the issues with universal broadband deployment. In section III, we report the economic impact of current broadband availability on income, jobs and taxes in Hamilton County. In section IV, we present estimates of the direct and indirect effects of potential second-generation FTTH technology in the county. Section V contains an evaluation of the community return on an FTTH project. Section VI concludes and highlights the policy implications of our research.

II. Broadband Technology

"Computers are everywhere except in the productivity statistics."

Robert Solow

During a 2005 speech, soon-to-be Chairman of the Federal Reserve Board, Ben S. Bernanke, commented on the temporal link between Information and Communications Technology (ICT) growth:[11]

> *In attempting to explain the relatively loose temporal link between ICT investment and productivity growth, economists have emphasized that much more than the purchase of new high-tech equipment is needed to achieve significant gains in productivity.*

He goes on to explain the importance of having a carefully thought out plan for applying new technologies before they are actually acquired. He summarizes the impact in terms of productivity growth, citing an average gain of better than 4 percent per year since 2001. Bernanke also cited (the above quote by) Solow to illustrate the point that the impact felt by changes to ICT investment is loosely linked in a temporal sense to the gain in productivity. Bernanke concludes with the observation that relatively optimistic estimates of secular productivity growth tied to the advancement of the technology frontier do not seem unreasonable and that continued growth in productivity will be in the range of 2 to 2 ½ percent per year.

[11] Available at: http://www.federalreserve.gov/boarddocs/speeches/2005/20050119/default.htm

Varian et al (2002) point out that although the internet stands as one of the most important innovations of our times and incontrovertibly has impacted the way business is conducted, the quantifiable impact is difficult to fully measure. Data on the volume of sales in B2B and B2C transactions place the impact of the internet in the U.S. in the hundreds of billions of dollars. They also point out that the most important measure of the internet's overall impact is the extent to which it enhances the standard of living of those who use it. Innovations like the internet improve the growth rate of productivity, which is measurable to some extent. The consensus, they write, is that "the internet, at a minimum, could generate added productivity growth of at least 0.5 percent annually." However, they point out that the internet also generates benefits that cannot be easily measured, such as "added convenience, the ability to customize products and services, and the social benefits of new forms of interaction, communities, and expression that the internet has made possible."

IT capital investment has been shown to significantly explain increases in national productivity (Stiroh, 2001). By some accounts, IT accounted for at least half of the productivity gains in the U.S. economy since 1995 and was responsible for at least a half percent decrease in inflation.[12] Jorgenson (2001) estimates a contribution of 22 percent of GDP growth attributable to IT capital investment. Oliner and Sichel (2000) conclude that IT investment was responsible for two-fifths of the growth in total factor productivity and 68 percent of the accelerated growth in labor productivity.

Key to the advancement of productivity through ICT is the continued adoption of enabling infrastructure in the area of network communications. Ongoing advancements in the delivery of access points to the internet provide both businesses and consumers with new opportunities to enhance their productivity at work and at home. The widespread and economical availability of first generation broadband (ADSL, Cable, T1, etc) has resulted in the shift of the majority of Internet users from pre-broadband era technologies (dial-up) to first generation broadband. In addition to faster access speeds for data transactions, the availability of increased connection speeds has also resulted in an alternative delivery mechanism for other forms of communications. Examples include

[12] The U.S. Department of Commerce's "Digital Economy 2000". Available at: https://www.esa.doc.gov/Reports/DIGITAL.pdf

Voice-Over-IP (VoIP) as an alternative to telephone, iTunes as an alternative to the music store, and Over-IP-Video (OIPV) as an alternative to cable/on-air/video store sourcing of movies. In addition, increased bandwidth allows businesses to enable off-site productive work through secure technologies such as Virtual Private Networks (VPN) that allow just in time sharing of information with a remote user as if the user were physically connected at the physical location. In each of these examples, Moore's law of decreasing hardware costs have made it increasingly easier to justify the infrastructure investments necessary to take advantage of the technology.

It is interesting to note that all of the services mentioned to this point are considered first generation broadband. Currently, the three most popular forms of first generation broadband are Digital Subscriber Line (DSL), Cable, and WiFi. DSL technology allows telecommunications companies to deliver internet service using the same copper wires that are currently used for phone service. The two main forms of this service are Asymmetric DSL (ADSL) being developed in the U.S. and Symmetric DSL (SDSL) being developed primarily in Europe. ADSL supports two different transmission rates – data can be downloaded from the Internet to a computer at rates between 1.5 to 9 Mbps (the downstream or downlink rate), and uploaded from the computer to the Internet at rates between 16 to 640 Kbps (the upstream or uplink rate). ADSL also allows the simultaneous use of the single pair of copper wires for both data transmission and voice transmission.

Cable technology takes advantage of open channel space that exists in the cable broadcasting system. Data is transmitted by allocating one or more open channels to downstream transmission and one or more open channels to upstream transmission. Like ADSL, the downstream and upstream transmission rates are asymmetrical, with the downstream rate being faster. Unlike ADSL, which provides a very consistent level of service, the actual cable based transmission performance varies with the number of subscribers actively using the network at any given time. Known as shared bandwidth, this form of technology makes it difficult to provide a consistent quality of service to cable broadband subscribers.

Wireless networking is a term applied to wireless networking equipment that supports the 802.11 standards. Equipment that supports the 802.11b version of the

standard is also known as WiFi (Wireless Fidelity). Currently, WiFi broadband providing transmission rates of 20+ Mbps is supported by the 9802.11g version of the IEEE standard. Like cable, WiFi is a shared bandwidth system. Perhaps its biggest advantage is that it promotes flexibility of location as there are no point to point connections to be maintained between the transmitter and multiple receivers. Also, computers can travel into and out of the connectivity range of the WiFi access point allowing for a greater degree of flexibility over both cable and DSL. Consequently, WiFi is being implemented in or considered for several major markets in the United States (Lehr et al, 2004).

Although these services represent significant improvement in cost and performance over older technologies for business (T1, Fractional T1, ISDN, dialup) and consumers (dialup), consumers are still presented with several significant issues involved with them.[13] For example, the quality of service with cable based broadband is reduced as the number of subscribers increases. This is likewise true with wireless broadband, although equipment is now available that provides managed levels of bandwidth based on a planned infrastructure. Also, first generation broadband services such as cable, ADSL, and Satellite are asymmetrical in upload and download speeds, allowing for reasonably rapid downloading of information, but significantly lower speeds for uploading information.

To date, the best second generation broadband solution that addresses the challenges of quality of service and bandwidth limitations involves the use of fiber cable throughout the entire connection from the Internet to the end client. Fiber-to-the-home (FTTH) supports the technology "triple play" of Voice, Data, and Video services through an increase in available bandwidth brought into the home in a single fiber pipe. Like DSL, FTTH can be configured asymmetrically such that downstream and upstream performance can be tailored to specific situations. Unlike DSL, however, FTTH would be able to also configure its allocation of bandwidth such that a single customer would be able to balance the use of bandwidth in applications based on need through a bandwidth-on-demand solution. For example, a low resolution playback of a movie via the FTTH

[13] The Computer Science and Telecommunications Board in a 2002 report echoes this sentiment. Available at: http://www7.nationalacademies.org/cstb/pub_broadband.html

network could occur when simultaneous high quality phone calls and high speed Internet access are needed. However, the customer could choose to have a low quality voice conversation and slower access to the Internet in exchange for viewing a high definition movie instead. Tyco Electronics[14] suggest seven advantages of fiber over traditional copper media. They point out that fiber optics offers high bandwidth over greater distances with no danger of electrical interference. Fiber's smaller size and lighter weight give it an installation edge for pulling and installing, especially in tight spaces. Below we reproduce a table from their paper:

	Copper	**Fiber**	
		Multimode	Single mode
Bandwidth (100 meters)	100 MHz	1 GHz	> 100 GHz
Transmission distance	100 meters	2000 meters	40,000 meters
FCC EMI concerns	Yes	No	
EMI susceptibility	Yes	No	
Crosstalk	Yes	No	
Ground loop potential	Yes	No	
Weight	Heavier	Lighter	
Size	Larger	Smaller	

Since fiber based infrastructure is now available at a cost that justifies its use, even in the "last mile" connection into a business or residence (see Table 8 later in the text), it is interesting to compare first generation broadband (ADSL, Cable, WIFI) with second generation FTTH. Table 2 shows a summary comparison of these technologies with respect to the four criteria of downstream speed, upstream speed, security and quality of service. It is interesting to note that although two of the technologies listed support triple play applications, only FTTH does so with a consistent quality of service.[15] The support of a triple play solution with a consistent quality of service will allow a

[14] http://www.amp.com/products/technology/articles/ifo_wf.stm

[15] Triple play involves convergence and integration. This means that not only is voice, video, and data provided over a single broadband IP connection, but also that the operator equipment and subscriber experience are integrated. "Integrated" refers to having telephony integrated into the TV screen/EPG for example, providing such features as caller ID on the screen and checking voicemail through theTV by only using the remote control. It also means the service provider enjoys significant benefits because the back office OSS and converged softwitch/head-end are integrated and less costly and easier to manage.

residential customer to enjoy full media access into the home through one cable, requiring one home based access point. The reduction in required equipment, and the resultant ease of installation and maintenance is likely to provide the consumer with an increased value for the cost of information services.

Table 2. A Comparison of Broadband Connectivity Options

	Down stream Speed	Up stream Speed	Security Issues	Quality of Service	Comments
Dial-Up	56 Kbps	56 Kbps	Same as phone	Actual performance is slightly less (80%) than advertised due to data encoding over analog lines	
ADSL	1.5 - 9 Mbps	16 - 640 Kbps	Tapping phone Line – relatively easy.	Provides consistent access through dedicated bandwidth.	Supports Limited Triple Play
WIFI	1–20 Mbps	1–20 Mbps	Requires RF; Gear in Range of Wireless Node	Can be configured to provided consistent level of bandwidth, or can allocate available bandwidth on demand	Supports Limited Triple Play
Cable	4 – 8 Mbps	384 – 768 Kbps	Tapping Cable Connection – relatively easy.	Number of users dictates available bandwidth to single user. QOS can vary during a session	Supports Full Triple Play
FTTH	10 – 100 Mbps	10 – 100 Mbps	Difficult	Provides consistent access through dedicated bandwidth; Bandwidth can be allocated by provider, or within home to enable different combination of downstream/upstream combinations.	Supports Full Triple Play 2.5 Gbps max bandwidth

If the simplification of information access is of interest to the consumer, then one of the ongoing issues with upgrade of service involves the optimal technologies/deployment strategies. Several questions arise. How will the relevant technology evolve and what are the alternative delivery mechanisms? For instance, what will be the impact that will be felt by the entry of companies such as Google on the perceived value of broadband access? Google is currently purchasing fiber optic cable to be used as backbone for a nationwide network that will provide WIFI access in multiple markets at different levels of service (Peterson, 2005). Initial indications are that the low end offering will be 200MB at no charge. This is a significant level of service being provided as part of a strategy to "own the desktop" of personal computer users. It might

not be feasible for cable/telecom companies or municipalities that are basing their broadband solution on wireless to compete with a company the size of Google.[16]

Will existing first generation broadband providers be willing to invest in continued upgrade and expansion of their wireless infrastructure in light of the telecommunications industry down turn of 2001? There is currently an ongoing policy debate involving current telecommunication and cable providers on the one side, and municipal entities on the other that revolves around whether municipalities can and should enter into this area (Ferguson, 2002).

What is the potential impact of introducing residential FTTH in an area such as Hamilton County? It is difficult to test the hypothesis that the demand for services in the current incarnation of the Internet represents its ongoing utility to users in the future, since current core usage is inhibited by the bandwidth constriction on the last mile to reach the consumers (Garvey, 2002). Other sections of this paper address this issue in more detail. Below we examine the current state of broadband in Hamilton County.

Broadband in Hamilton County

The availability of first generation broadband has been a key contributor to the success of Hamilton County's core business sectors. Some of these sectors, as described in the US Census Bureau 2002 data, are:

Professional, scientific, & technical services	762 Companies
Educational Services	54 Companies
Health Care and Social Assistance	940 Companies
Arts, Entertainment, and Recreation	112 Companies
Other Services (excluding public Admin)	650 Companies

Combined, these companies employ 24,474 people with an annual payroll of $815 million and combined revenues over $2 billion.[17] The area, long known for its railroad relationships, continues to benefit from the fact that large amounts of fiber optic cable has been laid along railroad right of way, which converge in Chattanooga. Because of this, businesses and consumers are able to access broadband, including fiber class speeds

[16] Gillette et al (2003) point out that wireless technologies that work well in some areas (e.g. the arid Southwest) may be unsuitable in others (e.g. tree-covered New England). Similarly, the choice of a next generation infrastructure for a greenfield development is likely to be different that for a community that is upgrading legacy infrastructure.

[17] US Census Bureau, Detailed Statistics on Hamilton County, TN from the 2002 Economic Census

through co-hosting from local ISPs that have their own connections to Tier one providers such as Sprint, AT&T, and KMC Telecom. Also available is a "last mile" fiber option through EPB Telecom that can be used by local businesses to increase their on-site connectivity speeds to that of fiber. In addition to the wired access to broadband, there are several areas of the city currently using wireless broadband, including municipal areas such as Coolidge Park, and educational institutions such as The University of Tennessee at Chattanooga. There is also commercial wireless broadband available from providers such as Air-Net, Chattanooga Online, and Earthlink.[18]

At present, fiber broadband is not offered to residential users. There are, however, a select group of commercial customers in industries ranging from medicine to manufacturing that have been using a direct fiber connection to EPB Telecom. Some of these customers have provided feedback as to their experiences. Although anecdotal in nature, their responses provide some insight into the potential that a fiber based connection will provide.

In considering the reasons for moving to a new broadband technology, the two most important benefits of using a fiber connection referenced by all of the users were the ability to support multiple services (e.g. voice, internet access, virtual private networks) using the same access point and being able to support uplink speeds such as 1.5 Mbps that allowed for the transfer of large datasets from various points of access.

To quantify the perceived benefits, users indicated several factors with respect to their decision to adopt the use of fiber to their business. For some, the fiber provider was able to either (a) match the current pricing structure of their previous service (for example, T1 equivalent speeds at the same cost as leasing an additional T1 line), or (b) provide a product at a price slightly above the user's former provider, but accompany it with services that made it a better value. In some of the cases, the users made their selection of fiber as part of a re-evaluation of their business use of services supported by broadband. Only one indicated that the new fiber based broadband service would be an addition to an existing T1, and that user is still required to maintain the T1 as a backup to the fiber link. The other users indicated replacing their broadband for data reasons, with

[18] Map of Tennessee Broadband Wireless ISPs: http://www.onelasvegas.com/wireless/TN.html

several taking the opportunity to also upgrade to VOIP technology for their telephone service.

Some of the users indicated that they would switch from their current broadband provider if compelling new applications, or significantly improved methods of providing existing services became available. It would seem that successful SGB deployment among residential and commercial users would depend critically on the price, perceived value and level of service. Informing and educating the public about the nature, scope and utility of upstream applications would also be paramount since typically consumers do not want what they do not know about.

III. The economic effects of current broadband availability in Hamilton County

Broadband is an accelerator of economic development. With broadband access, worker productivity increases, jobs are created and wages grow. It offers more services to consumers at lower prices, creating added efficiencies in both time and money. The economic benefits of broadband can also be attributed to indirect factors, including "increased e-commerce, reductions in commuting, increased consumption of entertainment, Internet telephony, and savings in healthcare as a result of sophisticated telemedicine" (Macklin, 2002). For businesses, the economic benefits result from efficiencies in the distribution of goods, services and information.

However, measuring the economic impact of broadband is difficult because broadband does not act on the economy by itself, but in conjunction with other Information Technology (IT) and associated organizational and social changes (Brynjolfsson et al, 2003, Lichtenberg and Lehr, 1998). As with computers and the internet, the effects of broadband are likely to be strongest in non-farm, and non-manufacturing industries, where productivity improvements are generally less well captured by economic data (Lehr et al, 2005, Varian et al, 2002).

The methodology we adopt to capture the economic impacts of broadband in Hamilton county utilizes the IMPLAN input-output methodology developed by the University of Minnesota. IMPLAN is an economic impact modeling system that is in use by over 1,000 public and private institutions. Its clients/users include federal and state

governments, universities, as well as private sector consultants. Economic impact studies using IMPLAN modeling are numerous, such as Tennessee Technology Center Economic Impact Study[19], Economic Impact of Aviation in Arizona[20], Economic Impact of Colorado Airports 2003[21], Economic Impact of the Museum of Fine Arts, Boston[22].

The IMPLAN Model

IMPLAN is a PC-based regional economic analysis system that uses input-output models as a means of examining relationships within an economy, both among businesses and between businesses and final consumers. At its heart is an input-output matrix that shows how much output each sector of the economy purchases from every other sector. This allows the model to trace impacts through a series of steps. IMPLAN captures all monetary market transactions for consumption in a given time period. The resulting mathematical formulae allow examination, based on a variety of multipliers, of a change in one or several activities on an entire economy segregated into over 500 different industries.

IMPLAN impact analysis enables us to generate impact reports for output/income, employment, employee compensation, proprietor income, indirect business taxes, and other property type income. Each report outlines the direct, indirect and induced effects of a particular economic activity. These are defined below:

- **Direct impact**: the employment or output associated with the activity itself. For example, student spending at area restaurants creates jobs at restaurants and increases the output of the region's "food and drinking establishment" industry.
- **Indirect impact**: regional purchases of inputs by businesses included in the direct impact. For example, in order to supply meals to students, restaurants must buy food from wholesale food distributors. The indirect impact includes the jobs and output associated with this multiplier effect.
- **Induced impact**: jobs created and output produced as a result of the expenditure of income generated in the direct and indirect impacts.

The total effect is the sum of direct, indirect and induced effects. This study focuses on three impacts: output/income, employment, and indirect business taxes.

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[19] www.tnstate.edu/ober
[20] http://www.edrgroup.com/edr1/consulting/2_7/P120-arizona-aviation.shtml
[21] http://www.edrgroup.com/edr1/consulting/2_7/P106-Colorado-airports.shtml
[22] http://www.edrgroup.com/edr1/consulting/2_6/P078-Boston-Museum-of-Fine-Arts.shtml