The Economic Impact Of Broadband: Estimates From A Regional Input-Output Model

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ABSTRACT

Like good roads, schools, and hospitals, cutting-edge broadband infrastructure is crucial to economic development and to the quality of life of local communities. Second-generation broadband (SGB), capable of supporting video, voice and data services simultaneously over a fiber-optic infrastructure, can provide users not merely faster internet connectivity, but a whole array of applications and communication services. This study provides an approach to quantifying the economic effects of first and second generation broadband availability in Hamilton County (TN) using an IMPLAN model. We find that household 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 while a new fiber-to-the-home project would cost $195.5 million over ten years, the economic impact of such a project would result in income and taxes exceeding $352 million while creating over 2,600 new jobs. We conclude that Hamilton County would benefit from the adoption of this technology.

Keywords: Broadband, FTTH, IMPLAN model, economic development

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. Crandall and Jackson (2001) point out that the potential consumer benefit from universal diffusion of broadband in the U.S. could top $500 billion. 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). To do so, we adopt in this study a popular methodology – the IMPLAN regional input-output model – used to evaluate the direct and indirect economic effects of public infrastructure projects such as roads, schools, and hospitals.

This paper has two objectives: 1) to quantify the economic effects of current broadband availability; and 2) to quantify the incremental effects of "next generation" or "second-generation" broadband associated with fiber-to-the-home (FTTH) technology. We focus our study on Hamilton County, a mid-sized community in the southeastern U.S. state of Tennessee.

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.[1] By 2004, about one-third of U.S. households subscribed to broadband. We refer to the ADSL/Cable modem-provided broadband services as first-generation broadband (FGB).

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. 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" 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, hereafter) when referring to FTTH technology 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.

This paper builds on the literature on the community impact of infrastructure – broadband, in this case - by examining 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. The county and the Chattanooga Metropolitan Statistical Area (MSA) consists largely of businesses in the healthcare, financial services, retail trade, and construction sectors.[2] The area currently receives mostly first generation broadband service in the form of cable or ADSL. More recently, a "last mile" fiber option through EPB Telecom, the municipal electric utility, has been adopted by a few local businesses. At the time of writing, fiber broadband was not available to residential users.

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 research on broadband impacts. In section III, we describe the IMPLAN model, while in sections IV and V we report estimates of the economic impact of first- and second-generation broadband availability on income, jobs and taxes in Hamilton County. Section VI concludes and highlights the policy implications of our research.

Table 1: Hamilton County Commercial Profile

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

[1] Cable modem was introduced in 1995 and DSL in 1997.

[2] The Chattanooga MSA consists of Hamilton, Marion and Sequatchie counties in Tennessee and Catoosa, Dade and Walker counties in Georgia.

II. LITERATURE REVIEW

A. Broadband Technology

IT capital investment has been shown to significantly explain increases in national productivity (Stiroh, 2001).[3] 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.[4]

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.[5] 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.[6] 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). 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.[7]

Although these services represent significant improvement in cost and performance over older technologies for business (T1, Fractional T1, ISDN, dialup) and consumers (dialup), adopters are still presented with significant issues of service quality and bandwidth limitations.[8] To date, the best second generation broadband solution that addresses these challenges 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. [9,10] In Table 2 we compare

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[3] 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. 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.

[4] 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 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.

[5] The two main forms of this service are Asymmetric DSL (ADSL) being adopted 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.

[6] 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.

[7] 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).

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

[9] 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

technologies with respect to the four criteria of downstream speed, upstream speed, security and quality of service. Of note is that although cable and FTTH support full triple play applications, only FTTH does so with a consistent quality of service. The support of a triple play solution with a consistent quality of service will allow a 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

B. Broadband Research

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, Osorio, Gillette and Sirbu (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 … 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 partial 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

example, a low resolution playback of a movie via the FTTH 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.

[10] Tyco Electronics points 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.

Lagrange (GA), among others. This strand of the literature can potentially be more useful to individual communities evaluating broadband choices.[11]

III. METHODOLOGY

The methodology we adopt to capture the economic impacts of broadband in Hamilton county utilizes the IMPLAN (Impact Analysis for PLANning) input-output methodology, originally developed by the USDA Forest Service in the mid-70s, and currently maintained and sold by MIG, Inc. (the Minnesota IMPLAN Group). The IMPLAN model 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.

The IMPLAN software allows the estimation of the multiplier effects of changes in final demand for one industry on all other industries within a local economic area. For a particular industry, multipliers estimate three components of total change within the local area, namely:

- *Direct effects* represent the initial change in the industry in question
- *Indirect effects* are changes in inter-industry transactions as supplying industries respond to increased demands from the directly affected industries
- *Induced effects* reflect changes in local spending that result from income changes in the directly and indirectly affected industry sectors.

The total effect is the sum of the direct, indirect and induced effects. This study focuses on broadband multiplier effects on Hamilton county income, employment, and indirect business taxes.[12]

It bears noting that the analysis to follow is limited by the use of a static model with static multipliers. Ideally, one would like to capture the dynamic impact of broadband. However, such an analysis would require continuous data, which is not currently available (See Ford and Koutsky, 2005), for use with dynamic optimization models.

IV. ECONOMIC IMPACT OF FIRST-GENERATION BROADBAND IN HAMILTON COUNTY

We measure the economic impact of FGB in Hamilton county from 2001 to 2005 by first estimating the total broadband expenditures in the county. This is obtained by multiplying the estimated number of household broadband users by the estimated annual fee per user. The broadband users (or "homes passed") include residential and business establishments. It bears noting that broadband service in the county over this period is essentially first generation broadband (i.e. cable and ADSL). Annual county expenditures on broadband are contained in Table 3.

[11] Ford and Koutsky (2005), for instance, compare economic growth in Lake County with other similar Florida counties during the period Jan-1998 to Nov-2004. They find that Lake County, which began offering private businesses access to municipally-owned broadband networks, 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.

[12] Income refers to earnings or labor income directly from wages/salaries; it does not include corporate income or profits. Employment impacts are calculated by converting labor income into an equivalent number of jobs based on industry average output per worker statistics. These numbers include both full- and part-time jobs. Indirect business taxes include excise and property taxes and fees; it does not include taxes on profits or income, or sales taxes.

Table 3: First generation broadband expenditures in Hamilton County (2001-2005)

Year	County homes passed	Broadband Penetration Rate (%)	County Broadband Users	Broadband Monthly Fee	Annual County Broadband Expenditures ($ mil)
2001	140,930	9.1%	12,825	$39	$6.0
2002	141,701	14.2%	20,121	$39	$9.4
2003	141,280	20.1%	28,397	$39	$13.3
2004	140,898	26.3%	37,056	$39	$17.3
2005	141,257	31.8%	44,920	$39	$21.0

Notes: County homes/household data is from the Chattanooga Area Chamber of Commerce and BLS Census 2000. Penetration rates are from Crandall, Jackson and Singer (2003) table 3. Monthly fees are from the Pew Internet & American Life Project 10/5/05

Next, we use the IMPLAN model to measure the impact of broadband in Hamilton County from 2001 to 2005. To do so, we input the county broadband expenditures into the "telecommunications" sector of the model for each year and allow the model to distil the direct, indirect and induced impacts of such expenditures in the county.[13] The results, summarized in Table 4 below, are in 2005 dollars.

Table 4: Economic impact of FGB in Hamilton County

Panel A. IMPLAN Year-wise Estimates

Total impact on → Year ↓	Income ($ million)	Indirect Taxes ($ million)	Employment
2001	9.23	0.60	49.07
2002	14.46	0.94	76.85
2003	20.47	1.33	108.60
2004	26.62	1.73	141.47
2005	32.31	2.10	171.73
Total	103.1	6.7	547.7

Panel B: Summary of impacts (2001-2005)

Impact on	Direct Impact	Indirect Impact	Induced Impact	Total Impact	Multiplier
County income	$69.4 mil	$18.9 mil	$14.8 mil	$103.1 mil	1.49
County taxes	$5.0 mil	$0.7 mil	$1.0 mil	$6.7 mil	1.35
County jobs	245.5	148.4	153.9	547.7	2.23

Table 4 shows that from 2001 to 2005, Hamilton county expenditures on broadband services had considerable direct as well as indirect and induced impacts on the local economy. Every dollar expended directly on broadband induced additional spending of approximately 49 cents and created jobs in the local economy.[14] The sector-wise impacts, which are suppressed for purposes of space, show that broadband expenditures generated $4.9 million of indirect and $0.19 million of induced impacts in the telecommunication sector, $1.8 million of indirect and induced impacts on the real estate sector, $1.8 million of induced impacts on the owner-occupied dwellings sector, etc. Cumulatively, broadband expenditures were responsible for about $103.1 million in income and $6.7 million in business tax revenues to the local government over the period 2001-2005. Direct expenditures in the telecommunication sector generated 246 jobs in that sector while cumulatively, broadband expenditures were responsible for about 548 jobs in the county in the 2001-2005 period.

[13] We use the 2003 IMPLAN model to generate these estimates. All data were adjusted for inflation using GDP deflators included in the model.

[14] The multiplier is calculated as the total impact divided by the direct impact, or 103.1 million / 69.4 million =1.49.

V. THE IMPACT OF A NEW FTTH BROADBAND PROJECT IN HAMILTON COUNTY

Next, we estimate the ten-year economic impact of overbuilding an FTTH network in Hamilton County. To do so, we initially generate cost estimates of the project in order to evaluate the multiplier effects on income, jobs and taxes from the IMPLAN model.[15]

Project Cost

The cost estimates associated with deploying an FTTH network in Hamilton County are based on the work of Render, Vanderslice & Associates, LLC (2005), hereinafter RVA. According to their report, FTTH deployment costs are based on: a) the number of homes to be passed, and b) the number of homes to be connected or served. Consequently, project costs are related to the geographic features of the area being served, and the take rate for services. In Table 5, we provide cost estimates from RVA, as well as a weighted average cost per home passed and per home served from Table 7 of Crandall, Jackson and Singer (2003), hereinafter CJS.

Table 5: Cost per Home Forecasts

Year	Overbuild passed cost (RVA)	Overbuild connect cost (RVA)	Overbuild total cost (RVA)	CJS (2003) Table 7
2006	$1,123.5	$770.0	$1,893.5	$1,152
2007	$1,109.7	$681.0	$1,790.7	$1,105
2008	$1,010.0	$621.0	$1,631.0	$1,060
2009	$950.1	$583.0	$1,533.1	$1,018
2010	$931.1	$571.3	$1,502.5	$977
2011	$912.5	$559.9	$1,472.4	$938
2012	$894.2	$548.7	$1,443.0	$901
2013	$876.4	$537.7	$1,414.1	$865
2014	$858.8	$527.0	$1,385.8	$831
2015	$841.7	$516.4	$1,358.1	$799

Note: Overbuild passed and connect costs are based on municipal overbuilds and are courtesy of RVA.

RVA's cost forecasts imply a 14 percent annual decline in homes passed and connect costs through to 2009. Beyond 2009, we conservatively assume a decline in cost of 2 percent per year. By contrast, CJS (2003) assume a decline of 5 percent per year in costs. Homes passed estimates for the county are based on population and business growth estimates. According to census data, Hamilton County population grew at a compound growth rate of 0.7% from 2000 to 2004, and is projected to grow at that same rate through to 2015. We project the same growth rate for households over the next ten years based on the latest census household data. Analogously, we assume business establishments will grow at an annual rate of 5 percent per year. The homes passed forecasts are in Table 6.

Table 6: Homes Passed Projections

Year	Projected Homes Passed	Incremental Homes Passed
2006	142,928	
2007	144,645	1,717
2008	146,410	1,765
2009	148,225	1,815
2010	150,092	1,867
2011	152,013	1,922
2012	153,992	1,979
2013	156,030	2,038
2014	158,130	2,100
2015	160,296	2,165

[15] A 2003 study by the Telecommunications Industry Association reports that SGB has implications for telemedicine, telecommuting, e-government, agriculture, distance learning, public safety and national security, tourism, e-commerce, and entertainment. In a separate study we generate estimates of the indirect social impact from an FTTH project in the county.

Based on the projected homes passed and overbuild project costs from RVA, we estimate a 10-year capital expenditure schedule beginning in 2006 subject to the assumption that all homes passed costs are fixed costs and are appropriated over three years at the rate of 50 percent in the first year, and 25 percent each over the subsequent two years. Connect costs are variable and dependent on take or penetration rates.

Take rate forecasts for FTTH services are varied. Below we present estimates of broadband penetration from CJS (2003), and two FTTH homes connected forecasts from RVA. It bears noting that the Table 3 estimates from CJS are for current FGB services, while the Table 7 estimates are for new users of advanced SGB services. RVA present separate forecasts of homes connected for Regional Bell Operating Companies (RBOC) overbuilds and for other overbuilds. While CJS's Table 7 estimates are for the entire U.S. population (including those that have access to fiber and those that do not), the RVA take rates are based on those that have access to fiber technology already. For Hamilton County we consider take rates that are an average of the two RVA estimates since we are examining a scenario where FTTH will be deployed in the county. These RVA average estimates are listed in the last column of Table 7.

Table 7: Take Rate Assumptions

Year	CJS (2003) Table 3	CJS (2003) Table 7	RVA44	RVAR	RVA Average
2006	36.7%	1.0%	44.0%	9.0%	26.5%
2007	46.6%	1.7%	44.0%	17.0%	30.5%
2008	53.4%	3.1%	44.0%	23.0%	33.5%
2009	59.8%	4.8%	44.0%	28.0%	36.0%
2010	65.6%	6.9%	44.0%	29.0%	36.5%
2011	70.7%	9.4%	44.0%	30.0%	37.0%
2012	75.3%	12.2%	44.0%	31.0%	37.5%
2013	79.2%	15.3%	44.0%	32.0%	38.0%
2014	82.6%	18.6%	44.0%	33.0%	38.5%
2015	85.5%	22.0%	44.0%	34.0%	39.0%

Notes: CJS Table 3 are for residential broadband penetration rates based on currently available technologies; CJS Table 7 are adoption rates for more advanced access technologies; RVA present separate forecasts of homes connected for RBOC overbuilds and for other overbuilds. RVA44 refers to their forecast for "other overbuilds", while RVAR refers to their forecast for RBOC overbuilds. RVA estimates beyond 2009 are courtesy of RVA.

Table 8: Capital Expenditures

		Take rate assumptions			
Year	CJS (2003) Table 3	CJS (2003) Table 7	RVA44	RVAR	RVA Average
	($ mil)	($ mil)	($ mil)	($ mil)	($ mil)
2006	$119.88	$80.85	$127.86	$89.59	$110.67
2007	$40.42	$39.90	$40.39	$40.08	$41.73
2008	$40.46	$39.91	$40.36	$40.13	$41.27
2009	$0.63	$0.05	$0.46	$0.30	$0.65
2010	$0.70	$0.07	$0.47	$0.35	$0.19
2011	$0.76	$0.10	$0.47	$0.41	$0.19
2012	$0.81	$0.13	$0.48	$0.47	$0.19
2013	$0.87	$0.17	$0.48	$0.52	$0.20
2014	$0.91	$0.21	$0.49	$0.58	$0.20
2015	$0.59	$0.25	$0.49	$0.65	$0.20
Cumulative	$206.0	$161.6	$211.9	$173.1	$195.5
PV @ 10%	$175.5	$136.9	$181.7	$146.3	$167.1

Total capital expenditures under different take-rate assumptions are presented in Table 8. To compute present values in this analysis, we use a discount rate of 10 percent commensurate with cost of capital estimates commonly used for the telecommunications services industry.[16] Our estimate of total project cost, in the last column of Table 8, is $195.5 million over a ten-year period, or $167.1 million in present value terms.

Economic Impact Of A New FTTH Network: IMPLAN Estimates

The total economic impact of a new FTTH project is comprised of two parts: a) the incremental impact of the new investment in the county, and 2) the impact of household expenditures on broadband service in the county.

Incremental New Investment Effects

The IMPLAN estimates below are based on the average capital expenditures listed in the last column of Table 8. In Table 9, we report the income, tax and employment effects of a new $195.5 million ten-year investment in FTTH infrastructure in the county.

Table 9: Ten-year economic impact of a new investment in FTTH infrastructure in Hamilton County

Panel A. IMPLAN Year-wise Estimates

Total impact on → Year ↓	Income ($ million)	Indirect Taxes ($ million)	Employment
1	220.34	12.79	1,511.40
2	83.23	4.82	559.8
3	82.47	4.77	543.8
4	1.30	0.07	8.4
5	0.38	0.02	2.4
6	0.39	0.02	2.4
7	0.39	0.02	2.4
8	0.40	0.02	2.4
9	0.40	0.02	2.4
10	0.41	0.02	2.4
Total	389.70	22.6	2,638

Panel B: Ten-year summary of impacts

Impact on	Direct Effect	Total Effect	Multiplier	Present Value of Total Effect
County income	$195.5 mil	$389.7 mil	1.99	$333.1 mil
County taxes	$14.1 mil	$22.6 mil	1.60	$19.3 mil
County jobs	683	2,638	3.86	

We find that the new investment could generate income of as much as $390 million to the county cumulatively over a ten-year period. The income multiplier is 1.99, suggesting that every dollar expended on SGB deployment induces an additional dollar in spending/income and elevates economic activity in the community. In current dollars, the cumulative income effect is about $333 million. Moreover, the new investment in FTTH infrastructure is expected to generate over $22 million ($19.3 million in present value terms) in new business taxes for the county. With an employment multiplier of 3.86, the FTTH investment is expected to create more than 2,600 new jobs in the county. While 683 new jobs are directly attributable to the new investment, another 1,955 jobs stem from multiplier effects in the local economy.

[16] Since churn rates tend to be very low for FTTH users, we do not consider churn in this analysis.

Household Expenditure Effects

It bears noting that regardless of whether consumers adopt SGB or continue to consume FGB services, broadband usage in the county will result in increased consumer spending in a variety of upstream industries. This spending will in turn result in increased capital spending by these upstream industries such as health care services, education, hotels and recreational services, etc. Estimates of these multiplicative effects over the next 10 years, contained in Table 10, suggest a further increase, in present value terms, of about $501 million in income and taxes. Additionally, over 5,000 new jobs are likely to be created on account of this spending.[17]

Table 10: Ten-year economic impact of household expenditures on broadband services in Hamilton County

Impact on	Direct Effect	Total Effect	Multiplier	Present Value of Total Effect
County income	$440.2 mil	$815.8 mil	1.85	$473.4 mil
County taxes	$31.4 mil	$47.8 mil	1.52	$27.7 mil
County jobs	1,389	5,111	3.68	

In sum, the ten-year incremental economic impact of the new broadband technology could generate as much as $352.4 million in income and taxes and over 2,600 new jobs in Hamilton county. In per capita terms, this amounts to an economic impact of about $506 per Hamilton County resident over a ten-year period.

VI. POLICY IMPLICATIONS

Our findings contribute to the significant policy debate on the appropriate means to realize the potential benefits from broadband. There is widespread agreement that policy should encourage broadband deployment and reduce digital divides. Perhaps the most controversial issue pertains to the role of local governments in providing broadband to smaller communities. Hauge, Jamison and Gentry (2005) 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. Gillette, Lehr and Osorio (2004) point out that heterogeneous communications infrastructure across local communities suggest a greater role for local communities in affecting how next generation broadband evolves. Support for the role of local governments in providing SGB infrastructure is also provided by McGarty and Bhagavan (2002) who conclude that there is a "wide class of municipalities for which a municipal broadband network is not only viable but is essential if the deployment of broadband is ever to be achieved." Kandutsch (2005), in tracing the similarities between early municipal electric utilities and current municipal broadband, points to market failure and the need for the service as a precondition for economic development.

However, McClure (2005) argues that, given the transience of broadband technologies and the high-risk nature of the telecommunication industry, municipal utilities ought not to automatically consider themselves players in this market. He points out that where the municipality is in a position to build its own fiber network and can make the economic case to do so, it should act as a wholesale transport carrier, maintaining open access to ISPs and cable providers to compete on the network. By doing so, the city/county reaps the benefits of fiber for underserved areas and for use by the municipality for education, health care and city services. But the majority of the risk, borne in the consumer marketing and service delivery aspects of the network, would shift to the private sector. The issue of the community's choice of whether to offer retail ("vertically-integrated") services or concentrate on wholesale ("open access") service provision needs further research.

[17] Household expenditures are based on a broadband monthly fee of $39 and take (or penetration) rates from Table 3 of CJS (2003). Recall that the Table 3 estimates from CJS are for current FGB services. We use this estimate of broadband penetration because we are trying to capture spending on broadband services regardless of whether consumers adopt SGB or continue to consume FGB services. We consider it reasonable to assume that broadband consumption will climb rapidly over the next ten years in line with CJS's estimates.

The slow deployment of cutting-edge broadband in the U.S. could reasonably be attributed to the high sunk costs associated with deployment of new communications infrastructure and the need for incumbent cable and DSL providers to exploit current infrastructure. Ferguson (2002) goes so far as to suggest that the U.S. lags the rest of the world precisely because of the current stable duopoly in residential internet services coupled with monopoly control in cable and voice services, both of which have stymied R&D and technical progress.

However, aside from capital costs, another major challenge to the deployment of SGB infrastructure pertains to consumer demand for upstream applications that are not as yet widely known about or commercially marketed. It is possible that private investors may not find a project worthwhile if the perceived demand (penetration or take-rates) does not seem like it will be high enough. Direct consumer demand for SGB is in the beginning stages primarily because the full potential of the technology is not widely known. Much of the appeal of SGB today hinges on, what seems like "futuristic" applications. Currently consumer demand for a more robust system is driven by anger at the incumbent telephone/cable company either because of maintenance or customer service issues. Market research suggests that the importance consumers attach to enhanced services is low compared to the fundamental attributes of reliability, product quality and price. In other words, consumers do not want what they do not know 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.

VII. CONCLUSION

This study sought to quantify the economic effects of current broadband availability in Hamilton County, and further to gauge the incremental economic effects of second-generation broadband (SGB) associated with fiber-to-the-home (FTTH) technology in the county. It bears noting that broadband is an enabler, and as such the effects of broadband technology are typically 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.[18] The approach taken in this paper builds on limited research in the area of broadband impacts. Philosophically, the approach taken is similar to studies dealing with the impact of airports, educational institutions, roads and other infrastructure projects. The economic impacts reported in this study are based on a regional input-output IMPLAN model for Hamilton County.

Our estimates indicate that household 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 while a new fiber-to-the-home project would cost $195.5 million over ten years, the economic impact of such a project would result in income and taxes exceeding $352 million while creating over 2,600 new jobs. We conclude that Hamilton County would benefit from the adoption of this technology.

Additional research into the indirect social effects of advanced technology could shed more light on the widespread adoption of such technology. Given that broadband is fundamentally changing the production functions across a wide range of industries, an interesting extension of this study, subject to data availability, would be to examine the dynamic effects of broadband on productivity, profitability, and future changes in county industry mix.

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[18] In related work, 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. This is because 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."

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