Economic Impacts of First-Generation Broadband on Hamilton County

We measure the economic impact of FGB in Hamilton county by first estimating the total broadband expenditures in the county. This is obtained by multiplying the estimated number of broadband users by the estimated annual fee per user. Annual county expenditures on broadband are contained in Table 3.

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

Year	County homes passed[23]	Broadband Penetration Rate (%)[24]	County Broadband Users	Broadband Monthly Fee[25]	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

Next, we use the IMPLAN model to measure the impact of broadband in Hamilton County from 2001 to 2005. The results, summarized in Tables 4-7 below, are in 2005 dollars.

Table 4. Income/Output impact of current broadband expenditures in Hamilton County (2001 to 2005, Top 5 Industries)

	Industry	Direct Impact ($ mil)	Indirect Impact ($ mil)	Induced Impact ($ mil)	Total Impact ($ mil)
1	Telecommunications	$69.4	$4.9	$0.2	$74.5
2	Real estate	0	$0.9	$0.8	$1.8
3	Owner-occupied dwellings	0	0	$1.8	$1.8
4	Architectural and engineering services	0	$1.7	$0.04	$1.7
5	Accounting and bookkeeping services	0	$1.4	$0.1	$1.5
	Total for all industries	$69.4	$18.9	$14.8	$103.1

[23] Based on data from the Chattanooga Area Chamber of Commerce and BLS Census 2000. We assume households and businesses will grow by 0.7% and 5%, respectively.
[24] Source: Crandall, Jackson and Singer (2003) table 3.
[25] Source: PEW Internet research shows monthly charges for broadband in the United States have not changed much over the past few years. Available at: www.pewinternet.org/pdfs/PIP_Broadband04.DataMemo.pdf,

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 induces additional spending of approximately 49 cents[26] and creates jobs in the local economy. In particular, broadband expenditures generate $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 are responsible for about $103.1 million in income in the county.

Table 5. Indirect business taxes impact of current broadband expenditures in Hamilton County (2001 to 2005, Top 5 Industries)

	Industry	Direct Impact ($ mil)	Indirect Impact ($ mil)	Induced Impact ($ mil)	Total Impact ($ mil)
1	Telecommunications	$5.0	$0.4	$0.0	$5.4
2	Owner-occupied dwellings	0	0	$0.2	$0.2
3	Real estate	0	$0.1	$0.1	$0.2
4	Wholesale trade	0	$0.1	$0.1	$0.2
5	Motor vehicle and parts dealers	0	$0.0	$0.0	$0.1
	Total for all industries	$5.0	$0.7	$1.0	$6.7

Broadband expenditures also have a fiscal or tax impact. Table 5 shows that cumulatively, broadband expenditures resulted in $6.7 million in business tax revenues to the local government over the period 2001-2005.

Table 6. Employment impact of current Broadband expenditures in Hamilton County (2001 to 2005, Top 5 Industries)

	Industry	Direct Impact	Indirect Impact	Induced Impact	Total Impact
1	Telecommunications	245.5	17.5	0.7	363.6
2	Food services and drinking places	0	3.1	20.3	23.4
3	Accounting and bookkeeping services	0	16.2	1.0	17.2
4	Architectural and engineering services	0	16.6	0.4	17.0
5	Employment services	0	9.4	2.8	12.2
	Total for all industries	245.5	148.4	153.9	547.7

[26] Multiplier=103,106,510 / 69,392,864=1.4858

Table 6 shows the employment effects of broadband expenditures in the county. Direct expenditures in the telecommunication sector generate 246 jobs in that sector in Hamilton County. These jobs generate additional spending which, in turn, generate another 18 jobs (i.e. 17.5+0.7) in the telecommunication sector; 23 jobs in the food & drink services sector; over 17 jobs in accounting and bookkeeping services, and so on. Cumulatively, broadband expenditures are responsible for about 548 jobs in the county.

Thus, as seen in Table 7, over the past five years, expenditures on current generation broadband have supported about 548 jobs and generated income and tax receipts amounting to $109.8 million in Hamilton County.

Table 7. Summary of the economic impacts of current broadband expenditures in Hamilton County (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

IV. Potential economic and social effects of second-generation FTTH broadband technology in Hamilton County

The advances made in the production and use of information and communication technology (ICT) during the past decades may have potentially large effects for long term economic growth. Indeed the substantial acceleration in real GDP growth in many OECD countries, but in particular in the United States, during the second half of the 1990s has led to suggestions that a "new economy" has emerged. In this new economy the old economic rules might have become invalid. For example, traditional concerns about the limits of maximum production capacity might disappear since the marginal costs of producing ICT goods and services are virtually nil. Moreover, the trade-off between inflation and unemployment could be reduced due to more efficient inventory management.[27]

[27] Measuring the New Economy: An International Comparative Perspective; Available at: http://www.ingentaconnect.com/content/bpl/roiw/2002/00000048/00000001/art00037

In a 2003 study, the Telecommunications Industry Association reports that current first generation broadband technologies do not meet the high bandwidth requirements for emerging applications that combine voice, video and data associated with second-generation broadband usage. Many of these applications require broadband symmetrically in each direction, both upstream and downstream, at speeds of 10 Mbps or higher. 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.[28] These applications are likely to be the true drivers of future economic and technological growth.

Next, we estimate the direct and indirect economic impacts of overbuilding an FTTH network in Hamilton County. To gauge the direct impact we initially generate cost estimates of the project and factor in the multiplier effects on income, jobs and taxes from the IMPLAN model. We then generate estimates of the indirect impact (or positive externalities) from an FTTH project in the county by focusing on select industries that are most likely to benefit from SGB applications.

Project Cost

The cost estimates associated with deploying a 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 essentially based on: a) the number of homes to be passed, and b) the number of homes to be connected/served. Consequently, project costs are related to the geographic features of the area being served, and the take rate for services. In Table 8, 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.

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

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

of 2% 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 2025. We project the same growth rate for households over the next ten years based on the latest census household data.[29] For this analysis, we assume business establishments will grow at an annual rate of 5 percent per year. The homes passed forecasts are in Table 9.

Table 8. Cost per Home Forecasts

Year	Overbuild passed cost (RVA)	Overbuild connect cost (RVA)	Overbuild total cost (RVA)[30]	CJS (2003) Table 7
2001	$3,077.0	$2,324.0	$5,401.0	NA
2002	$2,404.0	$1,810.0	$4,214.0	NA
2003	$1,808.0	$1,358.0	$3,166.0	$1,306
2004	$1,447.0	$1,086.0	$2,533.0	$1,252
2005	$1,197.0	$899.0	$2,096.0	$1,201
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

[29] CJS (2003) assume a 1.4 percent growth in U.S. households through to 2021.
[30] Overbuild passed and connect costs are based on municipal overbuilds and are courtesy of Mike Render at RVA.

Table 9. 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

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.

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 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 the Table 10.

Table 10. 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 Mike Render of RVA.

Total capital expenditures under different take-rate assumptions are presented in Table 11 below.[31]

Table 11. 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% [32]	$175.5	$136.9	$181.7	$146.3	$167.1

Used in IMPLAN modeling later.

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

[32] In this analysis we use a discount rate of 10 percent commensurate with cost of capital estimates commonly used for the telecommunications services industry.
See also: http://pages.stern.nyu.edu/~adamodar/

Economic Impact of FTTH Infrastructure Investment: IMPLAN estimates

The IMPLAN estimates below are based on the average capital expenditures listed in the last column of Table 11. In Table 12, we report the county income, tax and employment effects of a new investment in FTTH infrastructure in the county. We find that a ten-year $195.5 million investment could generate income of as much as $390 million to the county cumulatively over a ten-year period. The income/output 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.

The employment multiplier is 3.86. The FTTH investment is expected to create more than 2,600 new jobs in the county.[33] While 683 new jobs are directly attributable to the new investment, another 1,955 jobs stem from multiplier effects in the local economy.

Table 12. Ten-year economic impact of a new investment in FTTH infrastructure in Hamilton County

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	

Additional Economic Effects: Household Expenditure Effects

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. An estimate of these multiplicative effects over the next 10 years, contained in Table 13, suggests a further increase, in present value terms, of about

[33] By contrast, CJS (2003) use a RIMS II jobs multiplier of 18. They show that 61,000 new jobs could be created in the U.S. each year as a result of capital expenditures made on residential broadband between 2003 and 2021 by DSL and Cable providers. Pociask (2005) uses a jobs multiplier of 4.1 and predicts 1.2 million new jobs would be created by broadband investment.

$501 million in income and taxes. Additionally, over 5,000 new jobs are likely to be created on account of this spending.[34]

Table 13. Ten-year Economic Impact of Household Expenditures on Broadband Services

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	

Indirect Impact: The Incremental Social Benefits of Second Generation Broadband

An April 2004 report from the White House points to the indirect social benefits of broadband in the paragraph that reads:[35]

> *"Broadband technology will enhance our Nation's economic competitiveness and will help improve education and health care for all Americans. Broadband provides Americans with high-speed Internet access connections that improve the Nation's economic productivity and offer life-enhancing applications, such as distance learning, remote medical diagnostics, and the ability to work from home more effectively."*

In order to estimate the social benefits associated with SGB deployment in Hamilton County, we attempt to identify the parts of society most likely to be affected by such infrastructure availability. Research by Bauer, Gai, Kim, Muth and Wildman (2002) reveals that most of the potential benefits of second generation broadband are expected in six categories of applications: Telemedicine, Telecommuting, E-business, E-learning, E-government, and Media & Entertainment. Below we attempt to quantify some of the effects of SGB for select sectors of Hamilton County.[36] It bears pointing out that some benefits in each of these categories are already available via first generation broadband services to some extent. In the discussion below, we only focus on the incremental effects of SGB services.

[34] Household expenditures are based on a broadband monthly fee of $39 and take (or penetration) rates from Table 3 of Crandall, Jackson and Singer (2003).

[35] http://www.whitehouse.gov/infocus/technology/economic_policy200404/innovation.pdf

[36] This is not to say that there could not be other services and sources of benefits from SGB deployment. However, limited metrics and information restrict us to focusing on the most readily forecast benefits accruing to select sectors of the economy and stemming from select services.

Telemedicine

In the field of telemedicine, which is the provision of health care services, clinical information or medical education using telecommunications technology bandwidth requirements vary with the service provided. Clinical applications requiring large bandwidth include tele-diagnosis, tele-monitoring, tele-consultation, tele-radiology, the use of remote medical instruments, and behavioral healthcare mediated through telecommunications.[37,38,39] Analysts appear to agree that telemedicine will facilitate remote doctor visits involving the transfer of data and/or video conferencing, and constant or periodic monitoring of senior, infirm or chronically ill patients. President Bush's Technology Agenda envisions all health care records will be computerized within 10 years and this goal would be facilitated by widespread broadband infrastructure.

In addition to clinical applications, information and communications technology can reduce the administrative costs of health care providers and facilitate continuing education programs. In the spirit of Crandall and Jackson (2001), we attempt below to quantify a portion of the healthcare cost savings associated with chronic care patients needing tele-monitoring, tele-consulting and other services permissible with SGB.

The National Center for Health Statistics points out in their 2005 report that total health expenditures per capita were $5,670 in 2003, having grown by an average annual rate of 5.8% from 1990 to 2003. Accordingly, 2005 expenditures would amount to $6,347 per capita, if the same growth rate were to prevail. Moreover, if as pointed out by Crandall and Jackson (2001), chronic care patients account for 25 percent of all health care expenditures, then the expenditures attributable to chronic care could be estimated as follows:

% of total population with healthcare expenditures[40] x Average health expenditure per capita x % chronic care patients

For Hamilton County, the estimate would be:

(85% x 310,232) x $6,347 x 25% = $418.4 million

[37] Communities such as Leesburg (FL) deploy FTTH networks that enable public hospitals to transmit medical images such as MRIs and X-rays directly to doctors' offices for faster and better diagnosis.
[38] At 200 Kbps, transmission of a dozen X-rays would take more than one hour; over an all-optical network, the transmission would take just a few seconds.
[39] Table 2 in Bauer et al (2002) illustrates the different telecommunications needs of selected applications.
[40] The U.S. Department of Health reports that roughly 85% of the total civilian, non-institutionalized U.S. population had health care expenses.

Assuming all savings in health care expenditures are passed on to consumers in terms of lower health care costs, Table 14 below shows the increase in consumer surplus contingent on telemedicine causing a decline in health care expenditures of 10 to 50 percent.[41]

Table 14. Indirect Benefits from Telemedicine

Decline in healthcare costs due to telemedicine	Annual increase in consumer surplus ($ mil)
10%	* $ 41.8
20%	$ 83.7
30%	$125.5
40%	$167.4
50%	$209.2

* used in summary Table 21

Telecommuting

Telecommuting refers to working from home or satellite offices as opposed to commuting to a physical place of work. Research appears to show that telecommuting can contribute to time and cost savings as when employees share a reduced office space, use the same facilities on a rotating basis, or participate in a fee-based telework center arrangement. Savings come from simple sharing of large files, accessing the corporate network from home, and reduced office space rental and parking expenses. Telecommuting has also been shown to facilitate group collaborative projects. Additionally, firms could induce well-qualified people to a region, and assist persons with disabilities who are unemployed or underemployed. These and other factors contribute to reduced absenteeism, and improvements in employee retention rates, thereby reducing recruitment and training costs.

According to Crandall and Jackson (2001), the quantifiable benefits of telecommuting are the savings in transportation costs – both the time and expense of the worker, and the reduction in congestion and pollution costs imposed on others. Harder to quantify benefits include improvements in worker productivity and the expansion of employment opportunities for people with disabilities.

[41] According to Cyber-Care, the manufacturer of Electronic HouseCall, an Internet-based system that allows caregivers to monitor patients in their homes, independent industry studies have shown that remote monitoring of patient's conditions can reduce costs by 35 to 40 percent, while also improving care.

The U.S. Census 2000 shows that the average commute time to work in Hamilton County is 22.6 minutes (or 0.38 hours). This would imply a commute distance of 15.1 miles provided folks drive no faster than 40 miles per hour to work. According to census data, 146,824 people or about 93 percent of the workforce commutes to work in Hamilton County. Following Crandall and Jackson (2001), we assume that 30 percent of jobs in Hamilton County will permit telecommuting an average of 20 percent of the time (i.e. 1 day per week or 50 days per year) with the introduction of SGB services. Moreover, if, as Crandall and Jackson suggest, the average person values his/her leisure at one-half the hourly wage, then we can calculate the potential savings in travel time, cost and congestion as follows:

<u>Savings in travel time</u>

Labor force that currently commutes[42] x 30% possible telecommuters x (0.38 hours/day x 50 days) x Half median wage rate

143,435 x 30% x 19 hours/year x ($12.69/2)/hour = $5.1 million

<u>Savings in travel costs</u>

Labor force that currently commutes[43] x 30% possible telecommuters x Average commute miles per year[44] x average cost per mile[45]

141,012 x 30% x 753.3 x $0.42 = $13.4 million

<u>Reduction in congestion costs</u>

30% possible telecommuters x 20% reduction in commuting x peak multiple[46] x Half of total congestion costs per year[47]

30% x 20% x 2 x ($36 million/2) = $2.2 million

The total cost savings attributable to improved telecommuting adds up to $20.7 million. Table 15 below shows the total annual savings due to telecommuting when the assumption concerning jobs permitting telecommuting is varied:

[42] We exclude from this group those that already work at home.
[43] We exclude from this group those that walk to work, in addition to those that work at home.
[44] 15.0667 miles per trip times 50 days per year.
[45] Based on the University of Tennessee at Chattanooga Travel Policy.
[46] From Crandall and Jackson (2001) who use Krugman's approach.
[47] Source: Texas Transportation Institute's 2005 Urban Mobility Report. This is the estimate of average congestion cost for small urban areas (with populations less than 500,000) based on 2003 data. Available at: http://tti.tamu.edu/documents/mobility_report_2005.pdf

Table 15. Indirect Benefits from Telecommuting

Jobs permitting telecommuting	Savings in travel time ($ mil)	Savings in travel costs ($ mil)	Reduction in congestion costs ($ mil)	Total savings due to telecommuting ($ mil)
10%	$1.7	$4.5	$0.7	$6.9
20%	$3.5	$8.9	$1.4	$13.8
30%	$5.2	$13.4	$2.2	* $20.7
40%	$6.9	$17.8	$2.9	$27.6
50%	$8.6	$22.3	$3.6	$34.5

* used in summary Table 21

E-Business

E-business refers to the integration of information and communications technology into every stage of the value chain and thus is a much broader concept than e-commerce. It includes the use of advanced ICT to attract and retain customers, to streamline firm operations such as supply chain or inventory management, to automate business processes, and to collect, analyze and share business intelligence about customers and company operations with employees, suppliers, and business partners. There is widespread agreement that, with few exceptions, broadband is a prerequisite for the successful diffusion of e-business services. Although no concrete estimates of the overall benefits of e-business solutions are available, it is commonly expected that they include facilitating new ways of customer-supplier interaction, reduced transaction costs, and increased operational efficiency.

Besides the benefits that come directly from deploying and using broadband services, communities that have advanced broadband services may have a competitive edge in attracting and retaining businesses. That edge can become a significant competitive factor between businesses, as well as serve as an important aspect of economic development (Pociask, 2005).

One of the most touted benefits of advanced technology pertains to gains in productivity (Stiroh, 2001). The U.S. Department of Commerce reported that IT accounted for at least half of the productivity gains in the U.S. economy since 1995.[48] 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

[48] https://www.esa.doc.gov/Reports/DIGITAL.pdf

productivity. The attendant efficiency gains stemming from enhanced productivity comes from savings in personnel and time, streamlined and automated process flows, from less errors, from economies of scale and from lower processing costs per unit.

To quantify the effects of these gains in Hamilton County, we assume a portion of total employee time will be saved each week on account of advanced SGB services. Estimates are presented in Table 16 for different productivity assumptions. For instance, if we assume that 5 percent of total employee time per firm will be saved each week on account of productivity and efficiency gains stemming from SGB applications, this amounts to 2 hours per week or 104 hours per year per firm. The cost savings from such productivity gains can be computed based on the median wage rate as follows:

Hours saved per firm per year x median wage/hour

104 x $12.69 = $1,319.76 per firm per year

Table 16. E-Business Productivity Gains

Percent of total employee time saved per week	Hours per week Saved	$ per firm saved per year
1%	0.4	$264
2%	0.8	$528
3%	1.2	$792
4%	1.6	$1,056
5%	2.0	$1,320
6%	2.4	$1,584
7%	2.8	$1,848
8%	3.2	$2,112
9%	3.6	$2,376
10%	4.0	$2,640

In Table 17 below we show the annual productivity gains to the business community in Hamilton County assuming different commercial take rates for SGB services (and assuming 2 hours per firm per week will be saved due to the adoption of SGB services):[49]

[49] The gains are magnified manifold, if we assume instead that 5 percent of time *per employee* is saved each week.

Table 17. Indirect Benefits from E-Business

Businesses that take SGB services	Number of businesses	Annual productivity gains ($ mil)
20%	3,174	$ 4.2
40%	6,348	* $ 8.4
60%	9,521	$12.6
80%	12,695	$16.8
95%	15,076	$19.9

* used in summary Table 21

E-Government

Government can increase the number and level of public services available to citizens by putting new and existing services online.[50] As broadband becomes more widespread, public safety authorities will be able to develop systems for providing public safety alerts via the Internet.[51] Broadband allows local government jurisdictions to host Internet community forums and provide multimedia communication services on websites. RVA (2005) also point out that broadband-facilitated e-government could increase voter turnout at elections because of the possibility of online voting. Moreover, community meetings on local issues could be conducted remotely.

Broadband services are particularly beneficial to the disabled community. In addition to promoting greater civic participation and reducing the isolation that many disabled individuals feel, video phones with closed caption technology can greatly increase the ability to communicate for those within the deaf community. High-resolution computer screens and voice-activated programs can aid the visually impaired, and with software such as eBooks, everything from novels to textbooks can be downloaded. For the physically disabled and the elderly, the Internet, especially with a broadband connection, provides a means for them to connect and communicate with the world.[52]

[50] Union City, California has announced that it is replacing the telephone crime reporting system now in use with a system that will allow residents to file certain crime reports from their homes through the Internet. The new system will be less stressful for victims, eliminating games of "phone tag," while it eases the workload on community service aides and police officers. The $20,000 cost is projected to save the city $85,000 in salary and benefits annually.

[51] For example, the town of Herndon, Virginia is using its VOIP-based network to broadcast Amber Alerts to the IP based phones in local government offices.

[52] Wireless broadband offers another opportunity for the disabled. Rather than using a desktop computer, a wheelchair bound consumer with a mounted notebook computer can access the Internet from anywhere in his/her home. With voice-activated dialing, a physically disabled or visually impaired consumer can communicate more effectively and easily using VoIP over a wireless broadband connection.

Broadband infrastructure can also be a critical element in assisting a rural community to compete economically within the overall global business climate. Broadband infrastructure assists rural communities in attracting businesses, providing health care to residents and accessing government services. Broadband can serve as a critical link to information and news for communities that have limited newspaper, radio and television station choices. Access to broadband infrastructure can also improve the quality of education available to small population communities.[53]

The potential benefits of e-government result from savings in time and transportation costs involved with visiting local government offices, and savings associated with the reduction in government paperwork.[54]

Additionally, advanced broadband infrastructure would promote security and public safety. Such services as remote video monitoring of home, children, pets, and remote video monitoring of schools and businesses will enable greater public security. At a broader level, biometric screening at designated entry points/sensitive facilities, and remote surveillance of borders, ports, and airports will promote national security. Importantly, local benefits could include assistance to police, fire, first-responders and emergency personnel in crisis situations.

A quantifiable benefit of SGB technology to communities with locally-owned utility systems stems from specific utility applications. In particular, load monitoring, electric network management, automatic meter reading, and automatic outage reporting along with real-time environmental sensors are all enabled by greater bandwidth and speed. In Hamilton County, EPB Chattanooga is the local municipal electric utility. They estimate that in the EPB footprint 2,040,000 meters are routinely read each year and about 77,600 meters have to be re-checked, turned on/off or be read from a keyed

[53] For, example the California Mother Lode region - including Amador, Mariposa, Tuolumne, Calaveras, Inyo and Mono counties - has no state college or university and only one community college within the area's 18,546 square miles. High-speed Internet connections allow Mother Lode residents to access technology training and educational opportunities provided through the Golden Gate University's Cyber Campus. Students can remain in their communities, receive Bachelors and Master degrees online and with their advanced education, contribute to the economic vitality of the region.

[54] California State Controller Steve Westly has advanced a wide-ranging set of e-government proposals designed to save as much as $37.5 million annually by making the state more efficient at handling everything from tax returns to travel vouchers. Electronic filing of tax returns and refunds alone are expected to save up to $7.5 million each year. On-line processing of travel claims, payroll and benefits for state workers will bring additional savings of up to $29 million each year. See http://www.controller.ca.gov/eo/pressbox/2004/05/egov0512.pdf.

location. An estimate of cost savings to EPB (and therefore the city and county) from remote meter reading can be calculated as follows:

# of meters read per year x cost per meter reading

For the Hamilton County footprint, these savings amount to about $932,296 annually.[55] Additional savings from non-routine meter reading amount to $780,400.[56] The total savings to the electric utility from remote meter reading and monitoring could be as much as $1.71 million per year. All of these savings could ostensibly be realized within a very short period of time after deploying an FTTH network. Therefore, in summary Table 21, we consider the entire amount of the cost savings.

E-Education

RVA (2005) note that FTTH networks have helped expand communication between teacher/school and students and between teacher/school and parents. In some deployments, early efforts are underway to develop second generation online education which is more interactive and video-based rather than text-based as in first generation online distance learning.

Current asynchronous e-learning uses web-based learning modules but does not support real time interaction between the instructor and the students. Synchronous e-learning consists of on-line real-time lectures, which typically have to be joined by students at the time of their delivery. Additional asynchronous functions typically support the learning environment. Most demanding in terms of bandwidth are forms of collaborative e-learning in which students have to interact continuously to solve problems or engage in other learning activities. Table 3 in Bauer et al (2003) illustrates facets of e-learning that require SGB support.

SGB applications will contribute to the learning process to some extent.[57] However, estimating the benefit of such technology to the community is difficult. Although we do

[55] EPB estimates the cost per meter read to be $0.55 per meter. The number of homes passed is calculated to be 141,257 currently.
[56] Courtesy of EPB.
[57] The online/distance education system in Hamilton County is a possible beneficiary. Hamilton County Schools offers a Virtual School program that allows students to take courses online. Students are able to take up to 4 courses a year--one each semester and two in the summer. These classes range from remedial classes to help students catch up to AP classes to challenge students. Students can also take classes for

not include a numeric estimate of the benefits of SGB e-education services later in the analysis, we briefly discuss one approach to quantifying these benefits in terms of the possible impact of SGB services in reducing drop-out rates from public high schools. Data form 2003-4 suggests that the Hamilton County school system spends $7,807 per student. Moreover, the drop-out rate for grades 9-12 was 12.1 percent or 1,323 from among a student body of 10,930.[58] Drop-outs have the effect of increasing the per-student costs of the school system since a large part of the expenditures are on salaries and overhead. Consequently, some portion of $10,328,661 might be construed as inefficiently utilized expenditure on the part of the school system.[59] In Table 18 below, we present estimates of efficiency gains based on different assumptions concerning the effectiveness of SGB applications in the learning process and the positive impact it would likely have on student retention rates in Hamilton County:

Table 18. Indirect Benefits from E-Education

% reduction in drop out rate at the 9-12 grade level due to SGB technology ↓	% of per student expenditure wasted by drop outs →	Annual efficiency gains to the county school system				
		10%	15%	20%	25%	30%
1%		10,325	15,487	20,650	25,812	30,975
2%		20,650	30,975	41,300	51,625	61,950
3%		30,975	46,462	61,950	77,437	92,925
4%		41,300	61,950	82,600	103,250	123,900
5%		51,625	77,437	103,250	129,062	154,875

E-Entertainment

FTTH-enabled SGB would give the family access to the Internet and allow anyone in the house to use the phone at the same time; watch movies and video online; save money on phone bills by using instant messaging or making calls over the internet; listen to radio stations from around the world; work from home with access over

advanced credit so they can graduate early. Currently, students can not receive high school diplomas from online courses alone.

[58] Source: Tennessee State Department of Education and National Center for Education Statistics Available at: http://www.k-12.state.tn.us/rptcrd04/system.asp and http://nces.ed.gov

[59] Estimated as follows: Per student expenditure x number of 9-12 grade drop-outs

broadband and a virtual private network to one's office system; help children with school projects and homework; play interactive computer games online with likeminded people around the world;[60] use online banking to manage finances; learn new skills and hobbies online with e-learning; be online 24/7 for one fixed cost per month.[61,62,63]

Moreover, there is evidence that SGB will facilitate the growth of "smart homes", where homeowners can utilize broadband technologies to control the electronic devices in the home remotely. Lighting, heating and air conditioning, appliances, and home security and other systems can be remotely monitored and controlled. In addition, advanced energy metering technology in the home will allow consumers to control their energy demand and respond to market signals.

Quantifying such benefits is difficult. However, one can get some idea of the potential benefits from the following applications:[64]

VOIP Cost Savings

According to the January 2005 issue of Consumer Reports, consumers are saving $20 to $50 or more a month by using Voice Over Internet Protocol (VOIP). A nationally-

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[60] Online interactive video and computer gaming is increasingly a leading driver of broadband deployment and use. It is forecast that the worldwide market for online games will reach $9.8 billion in 2009, a 410% increase over 2003 revenue of $1.9 billion. Broadband applications can provide gamers with the ability to connect directly with interactive, multi person, high-resolution, fast action, and complex online games. Broadband gaming technologies that create virtual-reality environments could be a precursor to sophisticated training and simulation applications with a myriad of uses in industrial, entertainment, military, and commercial settings.

[61] See: http://www.cibi.org.uk/homebens.htm

[62] See also: "A growing demand for broadband," Broadband Properties, February 2005.

[63] Recently, Nortel Networks along with market research firm Pollara, Inc., conducted a survey focused on understanding the value of next generation broadband voice services to consumers. Their research revealed that the broadband user's communication needs were topped by 1) Communication management tools, 2) Collaboration tools for schoolwork/home office, and 3) Video calling. They also found that broadband consumers are highly collaborative—especially broadband home office users. Over half of broadband home office users share documents with others, and 64 percent say that they use the telephone to work with others on projects. All broadband users were also interested in a broadband file transfer service (one which would let them instantly send large files to collaborators—even files too large to e-mail). They were interested in this service because over half of them download large files from the Internet on a regular basis. While broadband home office users planned to use collaboration services to increase productivity in working with customers, suppliers, and co-workers, broadband consumer parents would like collaboration services for their children to have these services to work on school projects with friends. PC video calling was one of the highest valued services among broadband consumers and was the highest valued service among broadband home office users.
Available at: http://www.nortel.com/products/01/mcomms/collateral/nn104043-090803.pdf

[64] See also: Broadband Deployment in California. Available at:
http://www.cpuc.ca.gov/PUBLISHED/COMMENT_DECISION/43597.htm

representative Consumer Reports survey of 201 VOIP users shows that more than half were highly satisfied using VOIP in light of costs, service, and problems.[65,66] Table 19 gives some indication of current VOIP pricing in the U.S. Hamilton County residents currently pay an average of $47.73 for local and long-distance phone service from Bellsouth (see Table 24 later in the text). With an average cost of $28.63, VOIP has the potential to save consumers in Hamilton County about $19 per month or $229 annually at current rates.

The FCC estimates that 95 percent of U.S. households have telephone service. Presumably the same percentage is true for Hamilton County. Potentially, VOIP service could save county residents almost $27 million a year. In Table 20A we present cost saving estimates for the county from use of VOIP services dependent on VOIP take rates.

[65] http://www.infozine.com/news/stories/op/storiesView/sid/12067/

[66] Voice over Broadband (VoBB) voice traffic in Europe skyrocketed in 2004, going from half a million connections to 2.5 million connections, according to a recent study from IDC, a research firm. It is expected that the number of connections will rise to more than 22 million by 2008, for total revenue of $7 billion, of which 60% will come from the consumer market. The study speculates that for many incumbent operators, this will not be a tempting scenario due to the prospect of cannibalizing existing revenue streams. Nevertheless, the incumbents will be forced into this market at the risk of losing out on customers altogether. The report also found that although VoBB was primarily used to provide secondary line services at the end of 2004, it will increasingly be used as the primary line through 2008, as unbundling becomes more common and providers embrace VoBB services to complete their triple-play bundle.

Table 19. VOIP pricing in the U.S.

Service Provider (Plan Name)	Rate per month
SunRocket	$16.60
ViaTalk	$15.95
Vonage (Residential Premium Unlimited)	$24.99
Lingo	$19.95
Speakeasy	$29.95
AT&T (CallVantage Service)	$29.99
Broadvox Direct (Residential Unlimited)	$29.95
Cablevision (Optimum Voice)	$34.95
Net2Phone (VoiceLine US/Canada Unlimited)	$29.99
Packet8 (Freedom Unlimited)	$19.99
Time Warner (Digital Phone)	$49.95
Verizon (VoiceWing Unlimited)	$34.95
VoicePulse (America Unlimited)	$34.99
Average	$28.63

Source: OrderVoIP.com and TeleTips
Note: All services offer unlimited minutes. All services offer full or restricted 911/E911 feature.

Table 20A. Indirect Benefits from E-Entertainment – VOIP Services

Households that take VOIP services	Annual cost savings from use of VOIP services ($ mil)
10%	$2.9
20%	*$5.7
40%	$11.4
60%	$17.2
80%	$22.9
95%	$27.2

* used in summary Table 21.

E-Shopping Cost Savings

Broadband internet connections provide a new option for retailing and product distribution. They provide alternative ways of doing business that can be used if and when they are more efficient. Consequently, they increase consumer choice and economic efficiency.

A National Science Foundation study indicates that the average adult spends about 30 minutes per day for non-grocery shopping and 15 minutes traveling for such shopping.[67] The time a person spends shopping is an important economic cost. Assuming

[67] Source: *See* National Science Foundation, "Family Time Use Study: 1998-1999 Time Diaries",

that the average person values his leisure at one-half the median wage, the time spent in non-grocery shopping/traveling is worth $0.5948 per person per day in Hamilton County.[68] Annually, this amounts to $217.12 per person. For the labor force in Hamilton County, this yields an estimate of the total cost associated with retail non-grocery shopping of $34.3 million. Assuming that 10 percent of this cost is considered wasteful and is avoidable with advanced SGB technology, our estimates suggest a cost saving of $3.4 million per year for the county.

However, some might not consider most of the time spent on shopping as wasteful. In Table 20B, we present cost saving estimates based on different assumptions concerning the wastefulness of time spent on non-grocery shopping:

Table 20B. Indirect Benefits from E-Entertainment – E-shopping

% of time spent on non-grocery shopping that is considered wasteful	Annual cost savings to Hamilton County ($ mil)
1%	$0.3
2%	$0.7
3%	$1.0
4%	$1.4
5%	* $1.7
10%	$3.4

* used in summary Table 21

Our findings on the indirect social impact of new FTTH-enabled SGB infrastructure are summarized in Table 21 below:

Table 21. Summary of Indirect Social Benefits to Hamilton County from SGB Deployment

Source of Benefit	Indirect Social Benefits ($ mil. each year)#
Telemedicine	$41.8
Telecommuting	$20.7
E-Business	$8.4
E-Government	$1.7
E-Entertainment	$7.4
TOTAL	$80.1

see asterisks markings in various tables in earlier sections of the text.

(See: http://www.webuse.umd.edu/data_analysis.htm).

[68] Half the median wage rate x 45/480 minutes per day = $12.69/2 x 0.09375 = $0.595 per person per day.

V. Community Return on Investment

A national debate is raging regarding whether markets or local government intervention would most effectively promote broadband growth in the U.S. Lenard (2004), McClure (2005a,b) 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. Proponents of municipal entry into broadband cite market failure, the value of cutting edge ICT infrastructure in economic development, and disincentives on the part of private providers based on the inability to capture all of the economic benefits of broadband deployment.

Most local governments that have entered the telecom market or are considering entry into this market tend to do so using a municipally owned electric utility as a base. Proponents of this strategy argue that local government entry into the telecom market is essential because competitive markets fail to provide the services that smaller communities need. While private enterprise does a good job of providing broadband where profitable, it does not provide timely deployment to address health, education and welfare issues in smaller markets. Moreover, while the utilities enjoy economies of scale and scope, they have a long history of building and maintaining critical infrastructure and operate not for profit, but rather in the public interest (APPA, 2004). They claim to offer citizens more choice, a better product and better service.

The arguments opposing the local government/municipal entry into the telecom market typically point out that government entry violates the principle that government should avoid entering markets where private firms are active. Lenard (2004) argues that the entry of government entities in the marketplace, tends to "crowd out" private enterprise, and that local governments tend to favor themselves on taxes or rights of way or otherwise compete unfairly. They are exempt from federal, state and local income taxes and may even receive other subsidies, all of which contribute to an unfair advantage relative to private competitors. Absent the subsidies and economic preferences, the municipal entities would lose money in a competitive telecom industry and generally contribute to inferior economic outcomes for citizens (e.g. higher electricity bills and

higher local taxes). Based on these arguments, fourteen states have adopted either complete or partial bans on municipal entry in telecommunications.[69]

Much of this debate revolves around the size of the externalities accruing from SGB deployment. An externality is a situation in which the private costs or benefits to the producers or purchasers of a good or service differs from the total social costs or benefits entailed in its production and consumption. An "external diseconomy," "external cost" or "negative externality" results when part of the cost of producing a good or service is borne by a firm or household other than the producer or purchaser. An "external economy," "external benefit," or "positive externality" results when part of the benefit of producing or consuming a good or service accrues to a firm or household other than that which produces or purchases it.

Externalities of either the "positive" or the "negative" sort create a problem for the effective functioning of the market because the "external" portions of the costs and benefits of producing a good are not factored into supply and demand functions of rational profit-maximizing buyers and sellers. Hence a portion of the costs or benefits will not be reflected in determining the market equilibrium prices and quantities of the good involved. The price of the good or service producing the externality will tend toward equality with the marginal personal cost to the producer and the marginal personal utility to the consumer, rather than toward equality with the marginal social cost of production and the marginal social utility of consumption. Thus, normal market incentives for the buyer and seller to maximize their personal utilities will lead to the over- or under-production of the commodity in question from the point of view of society as a whole, not the socially optimal level of production. Goods involving a positive externality will be "under-produced" from the point of view of society as a whole, while goods involving a negative externality will be "overproduced" from the point of view of society as a whole.[70]

In this section of the paper, we evaluate the return to the county from investing in an FTTH network. To do so, we compare the costs and benefits (both economic and social) developed in the previous section. We begin by quantifying the cost savings to the

[69] These states are Arkansas, Florida, Mississippi, Minnesota, Nebraska, Nevada, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia, Washington and Wisconsin.
[70] http://www.auburn.edu/~johnspm/gloss/externality

community from subscribing to a FTTH triple play versus purchasing voice/video/data services as currently offered.

Customer Cost Savings from Triple Play: Broadband Voice/Video/Data Services

It is widely believed that next- or second-generation broadband infrastructure needs an "integrated services framework" (ISF), because ISF drives end user demand which in turn drives the economics of SGB infrastructure (Vishwanathan, 2003). Such ISF typically takes the form of a "triple play". Triple play 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. This means having telephony integrated into the TV screen/EPG for example, providing such features as caller ID on the screen and checking voicemail through your TV by only using the remote control. Customers benefit from a triple play not merely from receiving one bill and having three key services combined and integrated, but also because of lower costs, and improved customer satisfaction. Moreover, such triple plays have tended to promote competition in local markets for the provision of such services.

Triple plays also result in service providers enjoying significant benefits because the back office OSS and converged soft-switch/head-end are integrated and less costly and easier to manage (Vishwanathan, 2003). If wireless/mobility is added, users are able to extend their TelcoTV experience on the road using their cell phone interfaces (and the service provider equipment includes converged FMC equipment).

Table 22 shows service bundling cost packages as of March 2005 in four markets, Sacramento (CA), Queens and Long Island (NY), Phoenix (AZ) and Charlotte (NC). Except for Comcast, all providers include at least wired telephony along with high-speed internet and video packages as their high-end or medium-range product. Based on this data, we assume an average cost of triple play service of $155 per customer per month based on the cost of high-end and medium-range services offered.[71]

To evaluate the potential cost savings to Hamilton County residences, we evaluate the services and costs associated with wired telephony, cable TV and high-speed internet

[71] ($189.1 + $121.5) / 2 = $155. Note, however, that this estimate is likely to be high. Jackson City, TN began offering FTTH service in May 2004. Their high-end triple play is currently priced at $135 per month. Tariff rates from Optilink (Dalton, GA) and Hometown Utilicom (Kutztown, PA) also suggest lower rates.