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The Economic Benefits Of Broadband And Information Technology

Patrick S. Brogan

THE ECONOMIC BENEFITS OF BROADBAND AND INFORMATION TECHNOLOGY

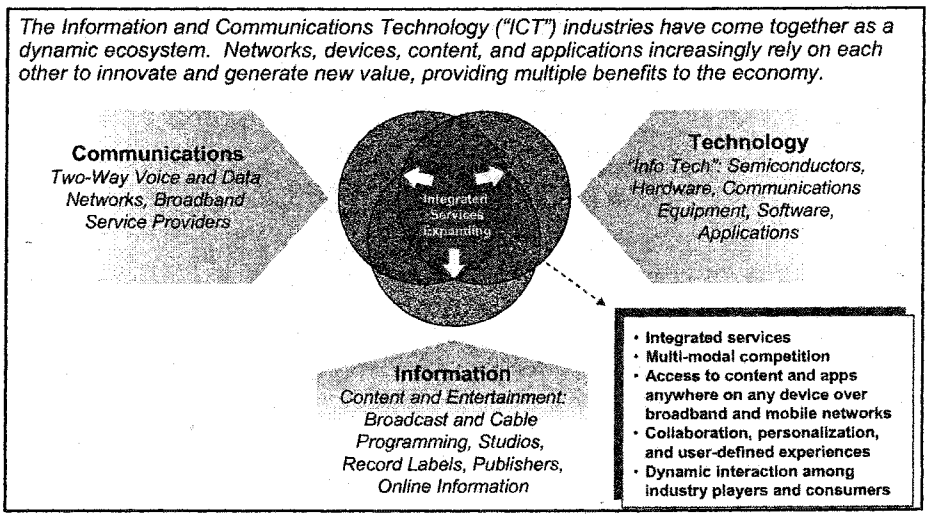
by

Patrick S. Brogan*

I
INTRODUCTION

Developments over the last half-decade have provided critical mass for the phenomenon of "convergence" – the coming together of the information, communications, and technology (ICT) industries technologically, economically, and competitively. In this dynamic and growing ecosystem, providers of broadband communications networks, digital devices, and a limitless array of content and applications all rely on each other to generate new value for consumers and multiple benefits for the U.S. economy. At the same time, ICT industries are competing across traditional industry boundaries. See Figure 1.

Figure 1: The Dynamic ICT Ecosystem



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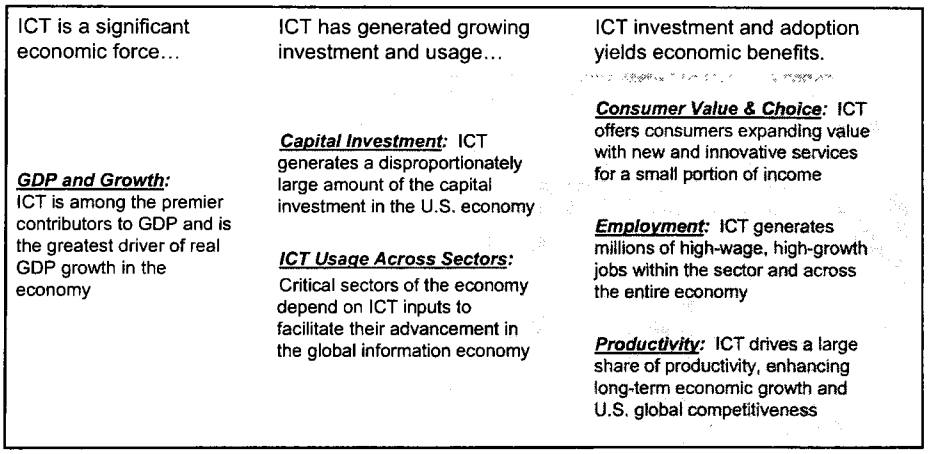
The purpose of this analysis is to illuminate the interdependence and competitiveness of the ICT industries, the growing impact of ICT on the broader economy, and the benefits of continued investment in this young, flourishing ecosystem.

The U.S. economy depends on the continued health of the ICT sector. Given the interdependence of ICT industries, the analysis that follows takes a holistic approach. It describes the economic impact of the full ICT sector, in relation to other sectors and in relation to the economy as a whole. The analysis begins with the contribution of ICT to economic output, or Gross Domestic Product (GDP). It then looks at growing investment in ICT and the use of ICT inputs across the economy. The analysis then explores the broader economic benefits of ICT, including the impact on consumer value and choice, jobs, and productivity. See Figure 2.

Figure 2: Framework for Analysis of ICT Economic Impact



Projecting the sector's successful growth into the future must be the key goal of relevant policymakers. Doing so will require careful attention by policymakers to the entire ICT ecosystem and the checks and balances that exist within it. Any change to current policies bears a heavy burden to demonstrate how that change could improve sector performance and to carefully account for the affects on jobs, growth and innovation as that change ripples through the ICT ecosystem. The risks involved in upsetting the balance that has produced the ICT record of economic success and innovation over the last several years should give pause to any policymaker considering changing course. Rather, policy

should maintain a positive climate of ICT industry and consumer-driven investment, innovation and growth.

II

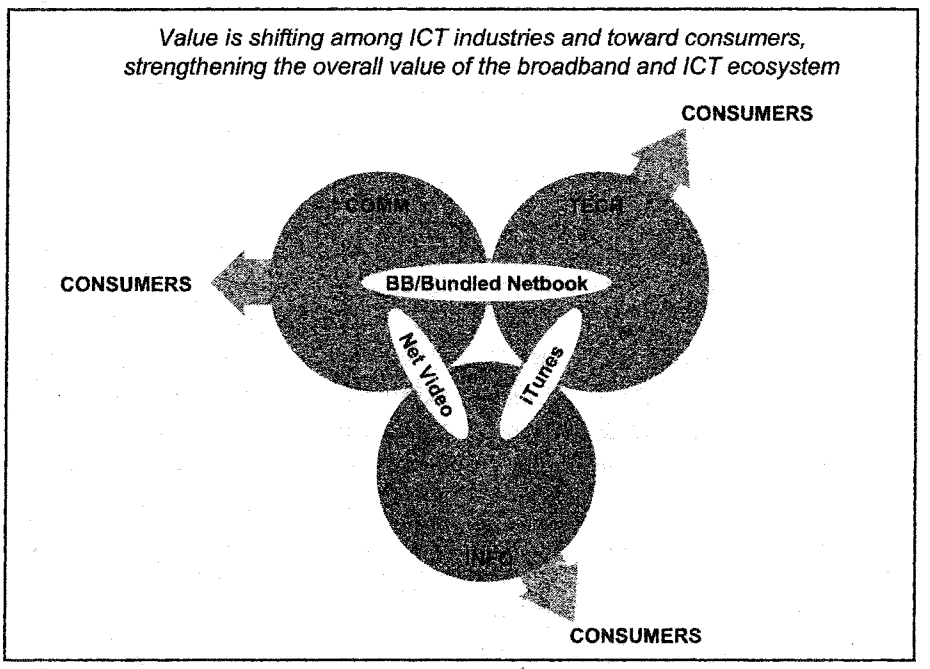
HOW CONVERGENCE HAS ALTERED THE ICT INDUSTRY DYNAMIC

As a result of convergence, the information, communications, and technology (ICT) industries[1] are at the same time interdependent and competitive. Industry players rely on each other to generate new value while competing across traditional industry boundaries to provide integrated services. The result is a relatively unfettered process of dynamic and flexible interaction among ICT players and consumers that has generated massive innovation. Consumers today can access a growing menu of content and applications anywhere, anytime using a growing choice of devices. New products and services are driven by collaboration, personalization, and user-defined experiences.

As this dynamic ecosystem grows, new broadband-enabled business models arise, creating new value and disrupting traditional relationships within industries. Perhaps less noticed, but of great importance, is the shifting of value between and among the ICT industries and consumers. See Figure 3.

[1] For this analysis, "ICT" industries" consist of information (digital or digitize-able content and entertainment), communications (broadband networks), and technology (information technology such as hardware, software, communications equipment). These industries are found in the following categories of the North American Industry Classification System (NAICS): Computer and Electronic Product Manufacturing, Computer Systems Design and Related Services, and the "Information" Industries, which consist of Telecommunications and Broadcasting, Publishing Industries including Software, Motion Picture and Sound Recording Industries, Information and Data Processing Services. The Computer and Electronic Product Manufacturing industry is part of the Durable Goods Manufacturing sector and the Computer Systems Design and Related Services industry is part of the Professional, Scientific, and Technical Services Sector. The analysis at times refers to the ICT sector, which consists of the collective ICT industries. *See* U.S. Census Bureau: North American Industry Classification System (NAICS), http://www.census.gov/eos/www/naics/. *See* Appendix, *infra* at 89, for discussion of GDP measurement as used throughout this paper.

Figure 3: Illustrative Examples of ICT Value Shifts



- iTunes: Apple, a technology company, has become the leading U.S. music retailer[2] using the broadband Internet and computers, disrupting the traditional music distribution chain. Value shifts away from the music industry (information) toward technology and consumers.

- Net Video: Online video services (e.g., Hulu, NBC.com, and ESPN360) are bypassing traditional content distribution, i.e., subscription video, using the broadband Internet. Value shifts away from subscription video toward content providers and consumers.

- Broadband Bundled Netbooks: ISPs have started to offer customers cheap, portable computers at a subsidized rate in

[2] Press Release, Apple, Inc., iTunes Store Top Music Retailer in U.S., (Apr. 3, 2008), http://www.apple.com/pr/library/2008/04/03itunes.html.

exchange for a term contract, like cell phones.[3] Consumer acceptance of this approach could bring more people online and shift value from and within the technology sector.

Whether well established (iTunes) or more experimental (online video, netbooks), these examples demonstrate how value can shift among ICT industries. Consumers capture value through cheaper, more powerful products and services. Industry value-capture is driven by flexible negotiation and interaction among ICT players. In this dynamic environment, shifting value and interdependence provide the checks and balances needed to ensure that consumers will benefit from sustained investment and innovation.

III
ICT IMPACT ON THE U.S. ECONOMY

A. ICT Impact on GDP and Economic Growth

The analysis begins with an examination of the ICT sector's contribution to GDP. To compare ICT to other sectors, we use GDP-by-Industry data from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). The data are based on the value-added approach to measuring GDP, as described in the Appendix Part A. The GDP-by-Industry data are provided at various levels of granularity, which allowed us to develop sector groupings appropriate for analysis.[4]

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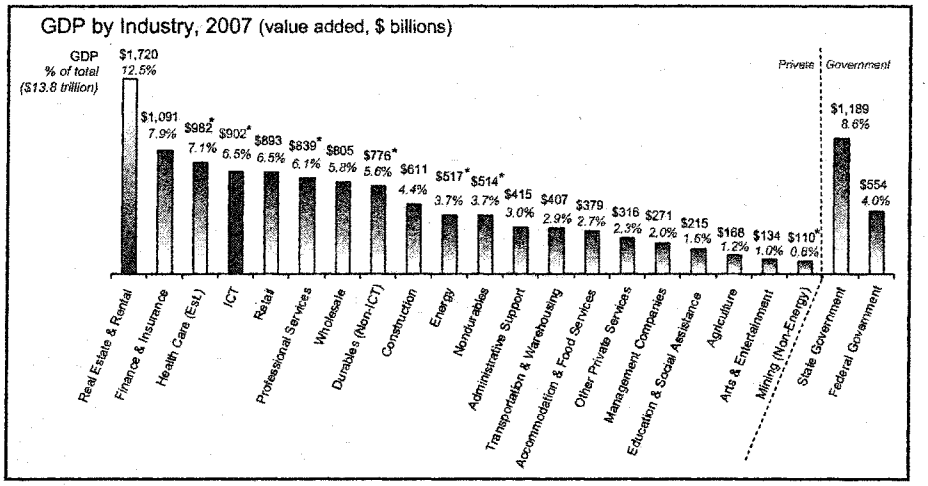
[3] *See generally*, *Get an AT&T Netbook for 50 Bucks – With a Catch*, CHANNELWEB (Apr. 1, 2009), http://www.crn.com/mobile/216402367.

[4] The ICT sector was formed by combining the Computer and Electronic Products Manufacturing industry from the Durable Goods sector and the Computer Systems Design and Related Services industry from the Professional, Scientific, and Technical Services sector and combining them with the Information Sector (consisting of the Telecom and Broadcasting, Information and Data Processing Services, Publishing Industries including Software, and Motion Picture and Sound Recording industries). We shifted Pharmaceuticals from Nondurable Goods Manufacturing to Health Care. Pharmaceuticals were estimated as 44.3% of chemicals product manufacturing, or $110 billion out of $249 billion for 2007, based on the Pharmaceutical portion of Chemical Manufacturing Value Added in the BEA 2002 Benchmark Input-Output Accounts. We also shifted $17 billion from Mining (Gas and Oil Extraction) and $70 billion from Nondurables (Petroleum and Coal Products) and combined with Utilities to form an Energy category. *See* U.S. Department of Commerce: Bureau of Economic Analysis (BEA), http://www.bea.gov/ (last visited Apr. 10, 2009).

The ICT sector contributed over $900 billion to GDP in 2007. ICT was among the top sectors in the economy at about 6.5% of the total GDP. Only the Real Estate, Finance, and Health Care sectors contributed more. See Figure 4.

Figure 4: Industry Contributions to GDP[5]



Moreover, ICT was by far the greatest contributor to *real* U.S. GDP growth.[6] Due to data limitations, we discuss *real* GDP in terms of the

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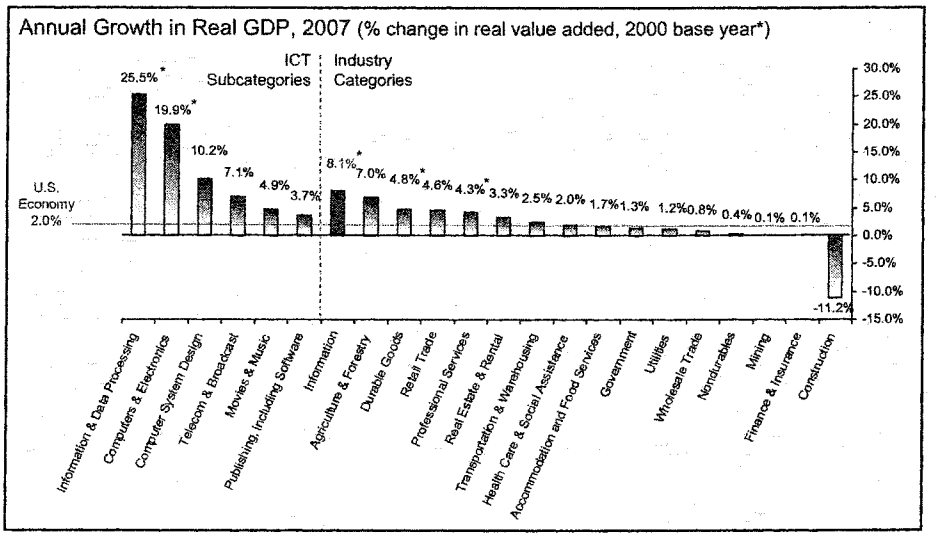
[5] BEA, GDP-By-Industry Data 1998-2007, *available at* http://www.bea.gov/industry/gdpbyind_data.htm (Figures are in nominal dollars, i.e., not adjusted for inflation or deflation).

[6] Real GDP accounts for the fact that consumers and businesses get more "real" output for the dollar from ICT due to declining prices and the increasing power of ICT products and services, such as computers and broadband. Real GDP presents several measurement issues that prevent us from looking at the real GDP of a combined ICT sector. Unlike the nominal GDP data, real GDP figures cannot be combined across industries, as we did with the nominal data to form a combined "ICT sector." This is because the "chaining" process that BEA uses to convert nominal to real dollars for each sector and industry yields real GDP figures that are not additive (i.e., the economy-wide total does not equal the sum of the sectors and the sector totals do no equal the sum of the industries). Therefore, we are limited to looking at growth for the sectors and industries for which BEA provides real GDP data. A note of caution on interpreting the chart: two sectors include ICT industries. These are the Durables and Professional Services sectors, which include Computer and Electronics Manufacturing and Computer System Design and Related Services, respectively. Therefore these sectors' growth

categories and subcategories provided in the government data, rather than our composite "ICT "sector. Real GDP for the Information sector—the category that comprises most of our composite ICT sector—grew 8.1% in 2007, greater than any other sector and four times the 2% rate of the economy as a whole. In fact, all of the subcategories comprising our ICT sector outgrew the overall economy: Information and Data Processing Services 25.5%; Computer and Electronic Product Manufacturing 19.9%; Computer System Design and Related services 10.1%; Telecom and Broadcasting 7.1%; Motion Picture and Sound Recording Industries 4.9%; and Publishing Industries (including Software) 3.7%. See Figure 5.

Figure 5: Industry Contributions to Real Economic Growth[7]



B. ICT Investment

We turn next to investment[8] because ICT investment has a disproportionate impact on GDP and is the source of many other

rates are overstated compared to rates that would result if the ICT component industry had not been included.

[7] *See* GDP-By-Industry Data, *supra* note 5 at tab 97NAICS_VA, GO, II, series code VACHN.

economic benefits, such as consumer value and choice, employment, and productivity. We address investment from two perspectives. First, firms across the economy, including firms in ICT and non-ICT industries, invested $455 billion in ICT equipment, software, and structures in 2008. Second, firms from the ICT industries invest in all types of assets, mostly but not exclusively ICT equipment, software, and communications structures. We look at the specific case of broadband service providers, who invested at least $64 billion in 2008, depending on the source and the methodology of estimation.[9]

1. *Economy-Wide Investment in ICT*

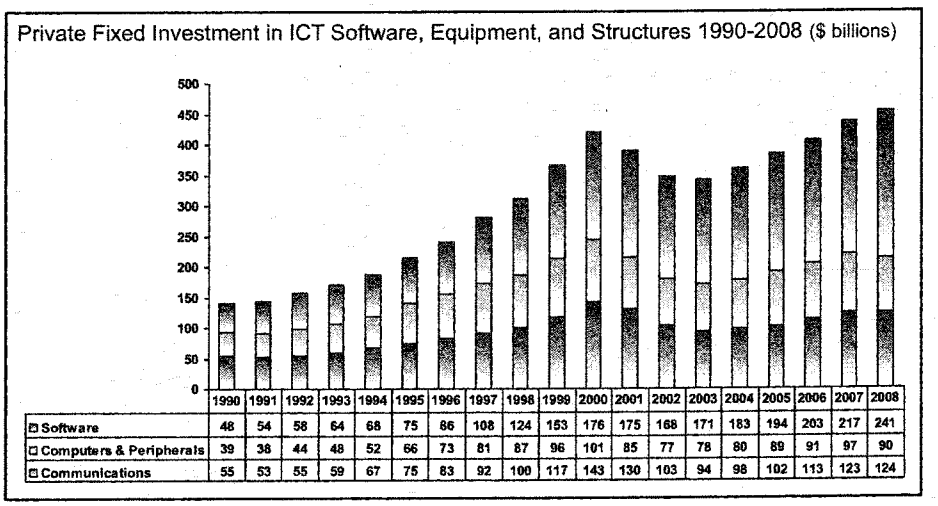
ICT investment contributes a disproportionately large share of U.S. private fixed investment. Private fixed investment across the U.S. economy in 2008 was $2.041 trillion, about fourteen percent of GDP. This investment consisted of $488 billion in residential investment, $555 billion in non-residential structures, and $999 billion in non-residential equipment and software.[10] Total 2008 investment in ICT equipment, software, and structures was $455 billion, consisting of $241 billion in software, $90 billion in computers and peripherals, plus $103 billion in communications equipment and $21 billion in communications structures. See Figure 6. The $455 billion of ICT investment represented twenty two percent of all private fixed investment and the $434 billion invested in ICT equipment and software accounted for forty three percent of non-structural investment.

[8] "Investment" as used herein refers to private investment in fixed assets. Governments also invest in ICT, but ICT investment is not broken out of government investment spending.

[9] Different sources for tracking capital expenditures are discussed in Part III.B.2, *infra* at 73.

[10] BEA, National Income and Products Accounts (NIPA) Table 1.1.5. Gross Domestic Product, *available at* http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N (last visited Apr. 10, 2009).

Figure 6: Nominal Private Fixed Investment in ICT[11]



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Software	48	54	58	64	68	75	86	108	124	153	176	175	168	171	183	194	203	217	241
Computers & Peripherals	39	38	44	48	52	66	73	81	87	96	101	85	77	78	80	89	91	97	90
Communications	55	53	55	59	67	75	83	92	100	117	143	130	103	94	98	102	113	123	124

ICT investment has grown substantially in the last half-decade. Since bottoming after the technology and telecommunications bubble of the late 1990s and early 2000s, annual ICT investment has grown by thirty three percent, from $343 billion in 2003 to $455 billion in 2008. Fueled by broadband, annual communications equipment and structures investment grew thirty two percent from $94 billion to $124 billion during the same period. *Real* annual communications equipment investment, which accounts for the effects of declining prices and the increased power of the equipment, was forty percent greater in 2008 than 2003 and surpassed the peak levels achieved in 2000 during the technology and telecommunications bubble.[12] See Figure 16.

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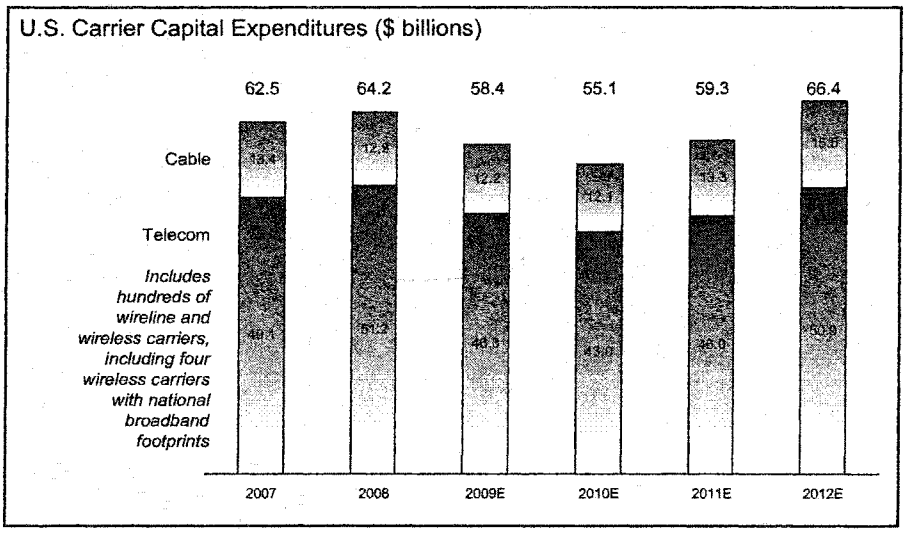
[11]BEA, NIPA Table 5.5.5U Private Fixed Investment in Equipment and Software by Type and Table 5.4.5BU Private Fixed Investment in Structures by Type, *available at* http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N.
(Communications structures include telephone, television, and radio, distribution and maintenance buildings and structures. *See* Paul R. Lally, *Survey of Current Business: How BEA Accounts for Investment in Private Structures*, BEA (Feb. 2009), *available at* http://www.bea.gov/scb/toc/0209cont.htm (last visited Apr. 10, 2009); *see also* related discussion of definitions and methodology for the Census Bureau's Monthly Construction Survey at http://www.census.gov/const/www/methodpage.html (last visited Apr. 10, 2009).

[12] BEA, NIPA Table 5.5.6U Real Private Fixed Investment in Equipment and Software by Type, *available at* http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N. BEA derives "real"

2. *Broadband Provider Investment*

Broadband providers invested at least $64 billion in 2008. Market research firm the Yankee Group estimates that broadband providers invested $64.2 billion in 2008, up from $62.5 billion in 2007. See Figure 7. The U.S. Census Bureau publishes broader capital expenditure estimates in the $80 billion range. Further, the Census Bureau publishes historical data showing that, like economy-wide investment in ICT, broadband provider investment has grown significantly over the last half-decade. Census estimates indicate annual carrier investment was thirty percent greater in 2007 than 2003. [13]

Figure 7: Carrier Capital Expenditures and Projections[14]



dollar measures by using a method called "chaining" that states current dollars in terms of the purchasing power of dollars in a base year, here 2000.

[13] U.S. Census Bureau, 2007 Annual Capital Expenditure Survey, Table 4a, and 2004 Annual Capital Expenditure Survey, Table 4b, *available at* http://www.census.gov/csd/ace/ (last visited Mar. 31, 2009). (The difference between the Census Yankee Group data cited is likely due to the broader scope of industries covered in the Census survey and differences in methodology. Census capital expenditure estimates are higher, $62 billion in 2003 and $80 billion in 2007.)

[14] Graphic created by US Telecom using source data from Yankee Group. © Copyright 1997-2009. Yankee Group Research, Inc. All rights reserved. Data are in nominal dollars. Includes wired and wireless telecommunications carriers and cable providers. Wireless spectrum license payments are not included.

Broadband era investment is based on a solid foundation of facilities-based last mile competition. The tech and telecom bubble era of the late 1990s to early 2000s was marked by strong ICT investment. Some investment yielded lasting value, such as the build out of corporate data networks, carrier fiber networks, national wireless networks, and the overall growth of the Internet. But much was driven by speculative investment. The broadband era, starting in roughly 2003, provides an instructive contrast. Investment is being driven in significant part by sustainable facilities-based competition for the last mile and continued integration of broadband ICT into the fabric of the economy. Examples of last mile broadband investment include deployment of fiber networks, such as FiOS and U-verse, upgrades to cable networks with DOCSIS 3.0, and implementation of wireless broadband technologies such as EV-DO Revision A, GPRS/HDSPA, WiMAX, and LTE. As noted above, we have surpassed bubble era investment levels.

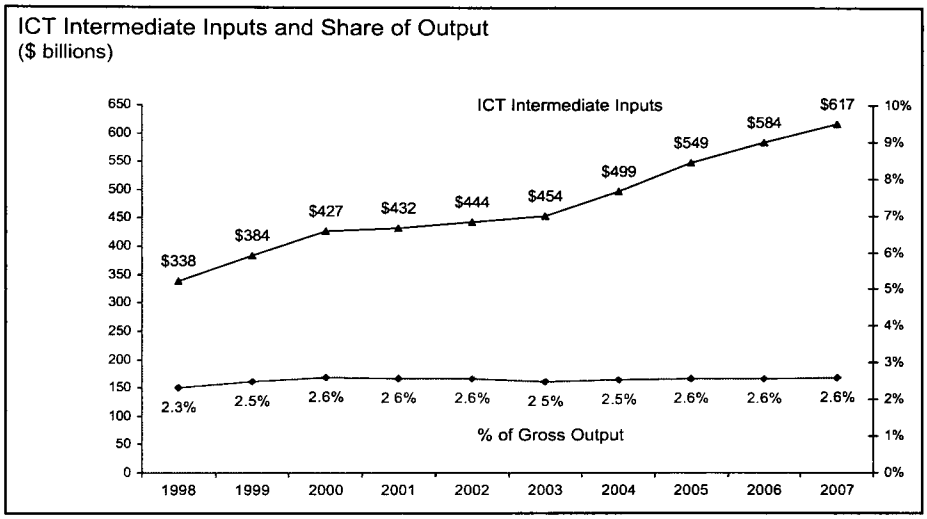
C. Intermediate Use of ICT

The U.S. economy depends on ICT inputs to thrive in the global information economy. Inputs are not directly measured in GDP.[15] Nonetheless, the growing use of ICT inputs indicates that ICT is becoming increasingly ingrained in the way U.S. firms conduct business. Non-ICT sectors spent $617 billion on ICT inputs in 2007 up from $338 billion in 1998. Yet, despite the growing power of the technology, spending on ICT consumed a relatively flat share of total output. See Figure 8. Including ICT sector use, ICT inputs were just over $1 trillion

[15] ICT intermediate inputs, or "inputs" for short, are similar to investment, but different in important respects. Inputs are similar to investments in that they reflect adoption and use of ICT technologies and services. But ICT inputs are different from investment in that they are not reflected in GDP—at least not directly. The key difference between an investment and an input is the investment contributes to future production and has a useful life of more than a year, whereas an input is used in production with a year. As shown in Appendix Part A, inputs are used to produce other products and services. Therefore inputs are reflected in GDP only indirectly through the sale of some other final good or service. Otherwise the value of the input would be double counted. For example, a manufacturer builds computer inputs into an automobile, but only the value of the automobile is reflected in GDP. A personal financial advisor utilizes voice and data networking inputs to monitor investments and communicate with clients, but its monthly networking bill is not reflected in GDP except through its fees, which recover its operational costs.

in 2007.[16] Critical sectors, including Professional Services, Health Care, Finance, and Government (which includes Public Education) are heavy users of ICT inputs. See Figure 9.

Figure 8: ICT Input Growth Over Time[17]



[16] BEA, Industry Economic Accounts, 1998-2007 KLEMS Intermediate Use Estimates, *available at* http://www.bea.gov/industry/more.htm (last visited Apr. 10, 2009).

[17] *See* 1998-2007 KLEMS Intermediate Use Estimates, *supra* note 16.

Figure 9: Non-ICT Industry Spending on ICT Inputs in 2007[18]

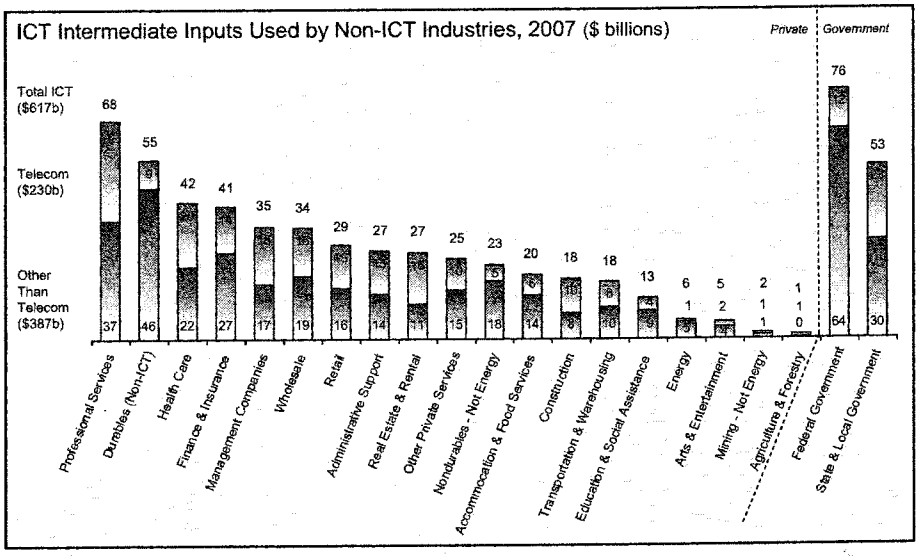
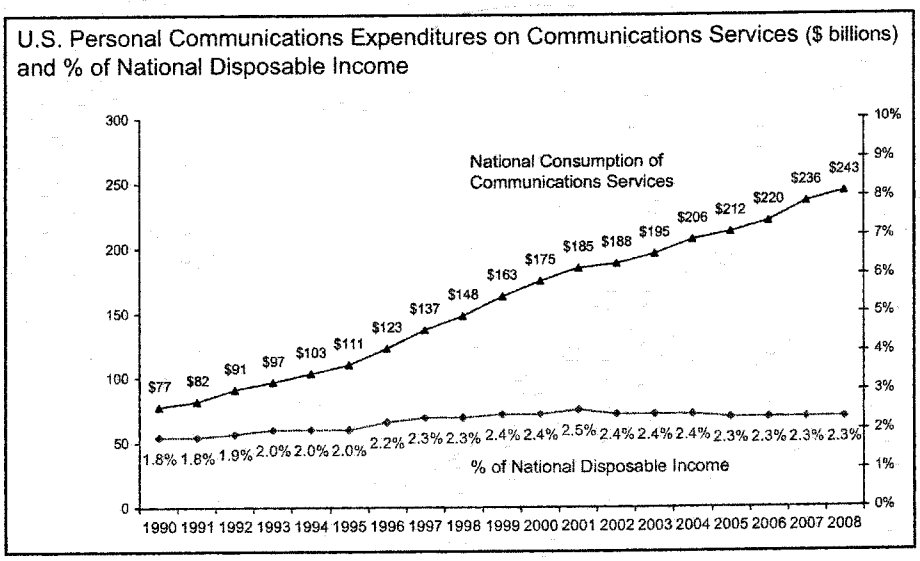


Figure 10: Communications Consumption and Share of National Income[19]



[18] *Id.*

[19] *Id.*

D. Consumer Value and Choice

ICT has provided consumers exponentially better value for a stable share of national income. Since 1990, consumer spending on ICT has grown from $197 billion to $545 billion, 5.1% of national disposable income in 1990, peaking at 5.9% in 2000, and falling to 5.4% last year.[20] Spending on communications services, a subset of ICT, has tripled over the same period, from $77 billion to $243 billion, and at 2.3% of national disposable income, up from 1.8% in 1990 but below its peak of 2.5% in 2001.[21] See Figure 10. Yet consumer value has grown exponentially in the intervening years.

For example, in communications, consumers have *exponentially* more and better choices today. Figure 11 shows that the mix of spending has shifted over time from traditional voice services to broadband, entertainment, and mobile services. Yet, while U.S. communications expenditures as a share of national disposable income have been flat since 1997, we have added over 100 million broadband and video connections, hundreds of new video programming choices, and over 100 million wireless connections.

- In 1990, the Internet was unknown to most of the U.S, yet by mid 2008, 55% of U.S. households subscribed to home broadband.[22] As broadband penetration has grown, new technologies such as fiber and mobile broadband have taken a growing share of new subscriptions. See Figure 12. Prices for basic wireline broadband services have dropped by half since the beginning of the decade. See Figure 13. By 2007, consumers could get 10-20 times the speed they could get for the same price as they paid at the start of the decade.

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[20] BEA, NIPA Table 2.4.5U Personal Consumption Expenditures by Type of Product, *available at* http://www.bea.gov/national/nipaweb/nipa_underlying/Index.asp; NIPA Table 2.1 Personal Income and its Disposition, *available at* http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N#S2.

[21] *Id.*

[22] John B. Horrigan, Home Broadband Adoption 2008, PEW Internet and American Life Project (July 2008), http://www.pewinternet.org/~/media//Files/Reports/2008/PIP_Broadband_2008.pdf.

- In 1990, there were approximately 52 million multi-channel video subscribers, compared to 99 million in 2008.[23] In 1994 there were 106 national cable programming networks[24] compared to 565 in 2006.[25]
- In 1990 there were 5 million wireless subscribers compared to 270 million in 2008.[26] Wireless consumers used an average of 140 minutes per month in 1993 compared to 769 in 2007.[27] Wireless data accounted for 18% of wireless service revenue in 2007.[28]

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[23] *See* National Cable & Telecommunications Association, http://www.ncta.com/Statistics.aspx (last visited Apr. 8, 2009) (2008 data includes 64 million cable and 35 million non-cable subscribers). 1990 data includes cable subscribers only (as non-cable subscribers were negligible) available at http://www.ncta.com/Stats/BasicCableSubscribers.aspx (last visited Apr. 20, 2009).

[24] *In the Matter of Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, FCC 95-491 at 72 (Dec. 11, 1995), *available at* http://www.fcc.gov/mb/csrptpg.html (visited Apr. 16, 2009).

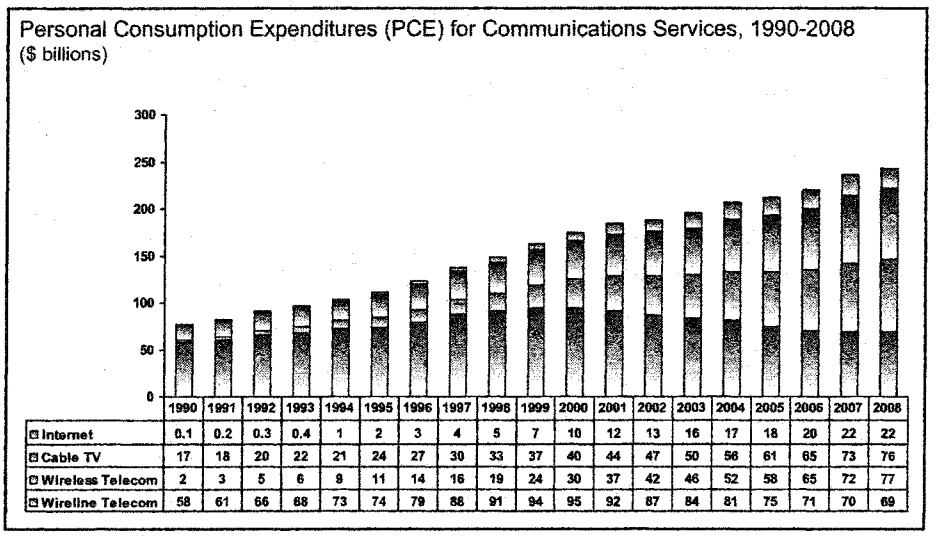
[25] *In the Matter of Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming,* Annual Report, FCC 07-206 at 9 (Nov. 27, 2007), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-07-206A1.pdf.

[26] Semiannual Wireless Industry Survey, CTIA: THE WIRELESS ASSOCIATION (Dec. 2008) *available at* http://files.ctia.org/pdf/CTIA_Survey_Year-End_2008_Graphics.pdf (visited Apr. 8, 2009).

[27] *In the Matter of Annual Report and Analysis of Competitive Market Conditions With Respect to Commercial Mobile Services*, FCC-DA 09-54, Table 12 at 93 (Jan. 16, 2009).

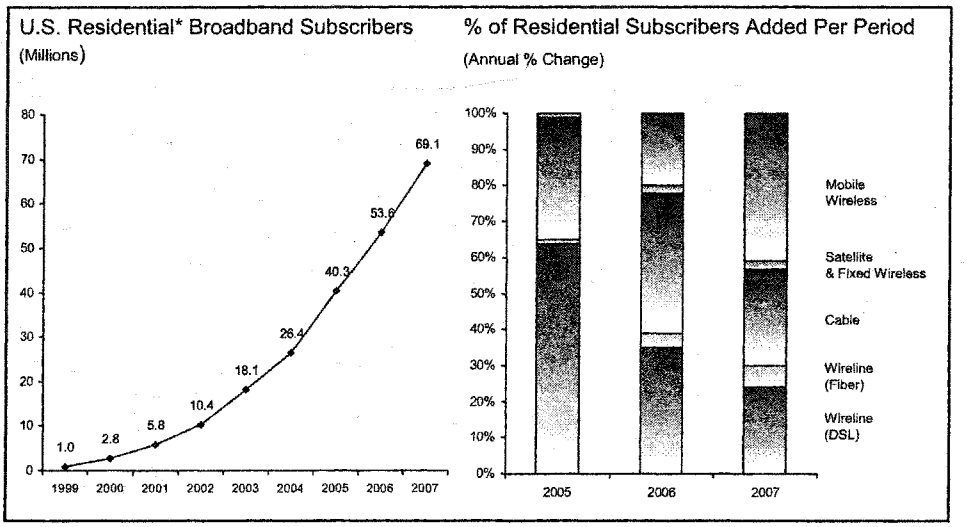
[28] *Id.*

Figure 11: The Changing Mix of Communications Service[29]



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Internet	0.1	0.2	0.3	0.4	1	2	3	4	5	7	10	12	13	16	17	18	20	22	22
Cable TV	17	18	20	22	21	24	27	30	33	37	40	44	47	50	56	61	65	73	76
Wireless Telecom	2	3	5	6	9	11	14	16	19	24	30	37	42	46	52	58	65	72	77
Wireline Telecom	58	61	66	68	73	74	79	88	91	94	95	92	87	84	81	75	71	70	69

Figure 12: The Changing Mix of Broadband Technology[30]



[29] *Id.*

[30] *See* Press Release, FCC, High-Speed Services for Internet Access: Status as of Dec. 31, 2007, (Jan. 16 2009) *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-287961A1.pdf (Data is based on FCC's most restrictive definition of broadband, i.e., residential "advanced services" that are greater than 200 kbps upstream and downstream.)

Figure 13: Weighted Average Monthly Price for Top 5 ILEC Wireline Broadband[31]

Year	Maximum Advertised Price by Downstream Speed Tier					
	Up to 768 kbps	768 kbps -1.5 mbps	Up to 3.0 mbps	Up to 7.0 mbps	Up to 15 mbps	Up to 30 mbps
2001	-	$50	n/a	n/a	n/a	n/a
2002	$28	$32	-	n/a	n/a	n/a
2003	$28	$30	-	n/a	n/a	n/a
2004	$30	$33	$46	-	-	n/a
2005	$20	$27	$33	$39	-	-
2006	$20	$23	$28	$36	-	-
2007	$18	$25	$28	$39	$51	-

E. Employment

ICT sustained at least 10 million jobs across the economy. Using the most current occupational employment data (2007), we are able see how broadband and ICT contribute to the job market both within and outside of the broadband/ICT industries.[32] In 2007, ICT industries sustained more than 5.7 million jobs, including 3.3 million jobs that are that were not ICT-centric and 2.4 million ICT-centric jobs. Non-ICT industries also employed 4.4 million in ICT-centric jobs. See Figure 14.

ICT jobs are among highest-earning and fastest growing jobs in the U.S. the economy. The ICT industry average wage of $29.43 is 50% greater than the national average hourly wage of $19.56 and ICT occupations pay, on average $27.05, about 38% more than the national average.[33] Based on Labor Department projections for 2006-16, ICT occupations are among the fastest growing in the economy. In fact, network and data communications analysts are the fastest growing

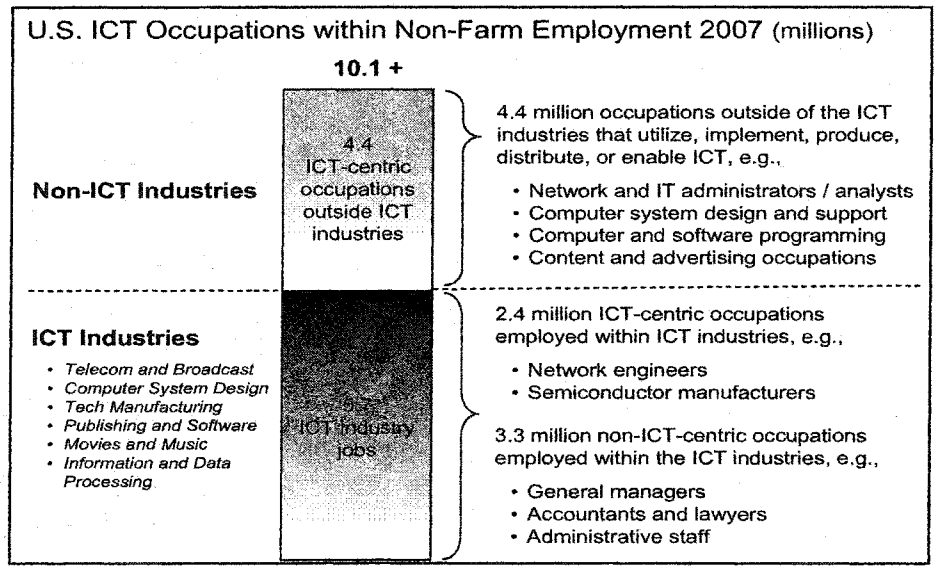
[31] Wireline Broadband Pricing 2001-2007, USTELECOM: THE BROADBAND ASSOCIATION (June 2008), *available at* http://www.ustelecom.org/uploadedFiles/Learn/Broadband.Pricing.Document.pdf (last visited Apr. 10, 2009). Copyright USTelecom 2008.

[32] Bureau of Labor Statistics (BLS), Occupational Employment Statistics 2007, *available at* http://www.bls.gov/oes/oes_dl.htm.

[33] *Id.* Averages are means. Industry and occupational wages are weighted by number of employees.

occupation in the economy at 53.4% growth over the ten-year period. Altogether, data network analysts, computer programmers and analysts, and database administrators were projected to add 625,000 jobs over ten years.[34]

Figure 14: ICT Employment[35]



F. Productivity

[34] BLS, *Employment Outlook 2006-16*, 130 MONTHLY LABOR REVIEW, No. 11, at 58, 95 (Nov. 2007), *available at* http://www.bls.gov/opub/mlr/2007/11/contents.htm.

[35] Occupational Employment Statistics 2007, *supra* note 32. The occupational employment data allow us to look at a cross section of occupations employed by industry. We looked at data for 295 industry subgroups and 800 occupations, classifying industries as ICT or non-ICT and classifying certain occupations as ICT-centric or not. ICT-centric occupations are those that exist to utilize, implement, produce, distribute, or otherwise enable ICT. Examples include network administrators or computer programmers. Jobs not specifically dedicated to ICT functions, but employed by ICT industries, might include accountants, lawyers, and office staff. Data do not capture agricultural or self-employed (9.7 million in May 2007) workers or the "multiplier effect" of jobs created outside of the ICT sectors to support ICT firms and employees (e.g., lawyers, property managers, general management consultants, and others). ICT occupations reported at subgroup level were 2.3 million, adjusted upward to 2.4 million to estimate industry total. See Appendix Part B for list of ICT-centric occupations.

Productivity is among the most significant economic benefit of ICT adoption because productivity is a critical determinant of the long-term economic growth and the living standards of our nation. Starting in the mid 1990s, economists began to find evidence that ICT is a significant driver of productivity growth. Productivity will remain critical to future economic growth because, when broken down into its components, GDP growth equals the sum of the growth rates of hours worked and productivity.

To understand how ICT affects productivity, consider that three factors drive growth in productivity, defined as output per unit of labor:

- Labor quality: improved education and skills yield greater output per unit labor.
- Capital deepening: investment in productive capital assets increases output per unit of labor; these assets include both ICT and non-ICT capital.
- Total factor productivity: a catch all to explain what is not otherwise explained, essentially it encapsulates innovation in business organization and production processes; total factor productivity includes both ICT and non-ICT firms.

ICT has no effect on productivity through labor quality or non-ICT capital deepening. ICT has a direct effect on productivity through ICT capital deepening and through total factor productivity within ICT firms. ICT may also have an indirect, or partial, effect on productivity through the total factor productivity of non-ICT firms.

Economists began to investigate the impact of ICT when productivity growth jumped from an average of about 1.5% during the period from 1973 to 1995 to an average at or above 2.5% from 1995 to 2000. Some economists have recently found that the direct impact of ICT from both ICT capital deepening and total factor productivity within ICT firms contributed between half and three-quarters of the productivity growth during the period. [36] The impact of ICT remained significant from 2000

[36] *See* Dale W. Jorgenson, Mun S. Ho, & Kevin Stiroh, *A Retrospective Look at the U.S. Productivity Growth Resurgence*, Federal Reserve Bank of New York, Staff Report No. 277 (Feb. 2007) (finding an average annual growth rate of 2.7% during 1995-2000, of which 1.01% was attributable to ICT capital deepening and 0.48% was attributable to total factor productivity of ICT firms, for a total direct ICT impact of 1.59% (59% of

through the middle of the decade, but was more muted: between 0.33% and 0.4%.[37]

Recently, economists have begun to look beyond the direct impact of ICT capital deepening and total factor productivity in ICT firms to determine whether ICT has an indirect or partial impact on the total factor productivity of non-ICT firms. The theory is that ICT is a "general purpose technology" that positively affects productivity in non-ICT firms, usually in combination with complementary investments in intangible capital such as training and organizational knowledge needed to utilize the ICT capital. Under this theory, the total factor productivity benefit lags the investment in ICT, possibly by many years. In fact the theory posits a negative concurrent correlation between ICT investment and total factor productivity because an organization's focus is on acquiring and installing technology rather than building the organizational knowledge needed to use it. Some preliminary studies have found some evidence in favor of this general purpose technology theory,[38] though the issue is the subject of ongoing inquiry.

Estimating the current dollar impact of ICT-generated productivity is an imprecise endeavor. We calculated a purely hypothetical "back of envelope" scenario, based on actual real GDP growth for the non-farm

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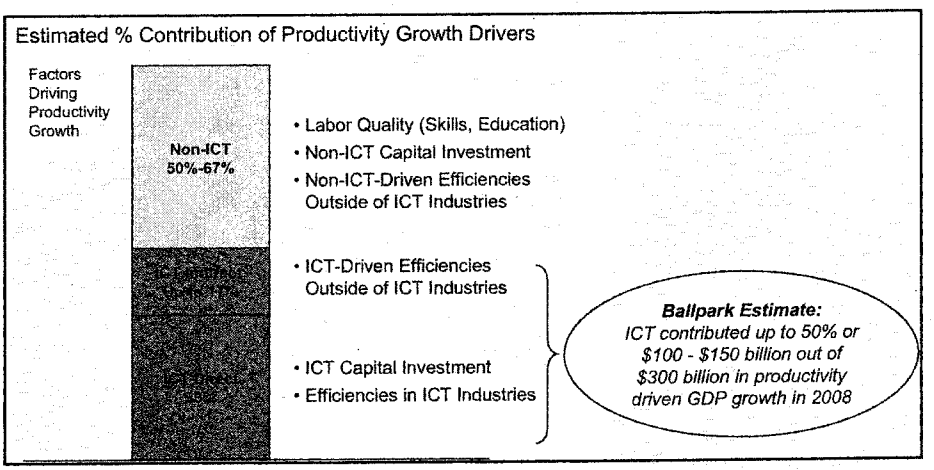
the total impact)). *See also* Stephen D. Oliner, Daniel E. Sichel, & Kevin J. Stiroh, *Explaining a Productive Decade*, Federal Reserve Board, Washington, DC, Finance and Economics Discussion Series (Aug. 2007) (finding that labor productivity grew at an average annual rate of 2.51%, of which ICT capital deepening was 1.09% and total factor productivity for ICT firms was 0.75%, for a total direct ICT impact of 1.84% (73% of the total impact)).

[37] *See* Jorgenson et al., *supra* note 36 at Table 1 (from 2000 to 2005 productivity grew 3.09% annually, of which 0.63% was attributable to ICT capital deepening and 0.4% was attributable to total factor productivity of ICT firms, for a total direct ICT impact of 1.03% (33% of the total impact)); Oliner et al., *supra* note 36 at Table 1 (from 2000 to 2006, productivity grew at an average annual rate of 2.86%, of which 0.61% was ICT capital deepening and 0.51% was total factor productivity for ICT firms, for a total direct ICT impact of 1.12% (39% of the total impact)).

[38] *See, e.g.,* Susanto Basu & John Fernald, *Information and Communications Technology as a General-Purpose Technology: Evidence from U.S. Industry Data*, Federal Reserve Bank of San Francisco, Working Paper (Dec. 2006); Barry P. Bosworth & Jack E. Triplett, *The Early 21st Century U.S. Productivity Expansion is Still in Services*, Int'l Productivity Monitor, No. 14, (Spring 2007).

business sector of 0.8% and annual productivity growth of 2.8% from 2007 to 2008.[39] We estimated that out of roughly $300 billion in productivity-driven GDP growth in the non-farm business sector, ICT could account for about $100 billion, possibly as much as $150 billion or more. Again, this estimate must be taken with a grain of salt. See Figure 15 below and discussion in Appendix Part D.

Figure 15: Illustrative Estimate ICT Productivity Contribution to 2008 GDP



IV
CONTINUED ICT GROWTH IS THE KEY POLICY OBJECTIVE

New policy approaches, rooted in the interdependent and competitive nature of the ICT ecosystem, have helped to spur the progress of convergence. Facilitating the continued growth of ICT remains a critical policy objective. The question will be how to encourage continued investment, adoption, and flexible interaction among industry players and consumers so that the ICT ecosystem continues to flourish and innovate. Doing so will require careful attention by policymakers to the entire ICT ecosystem and the checks and balances that exist within it.

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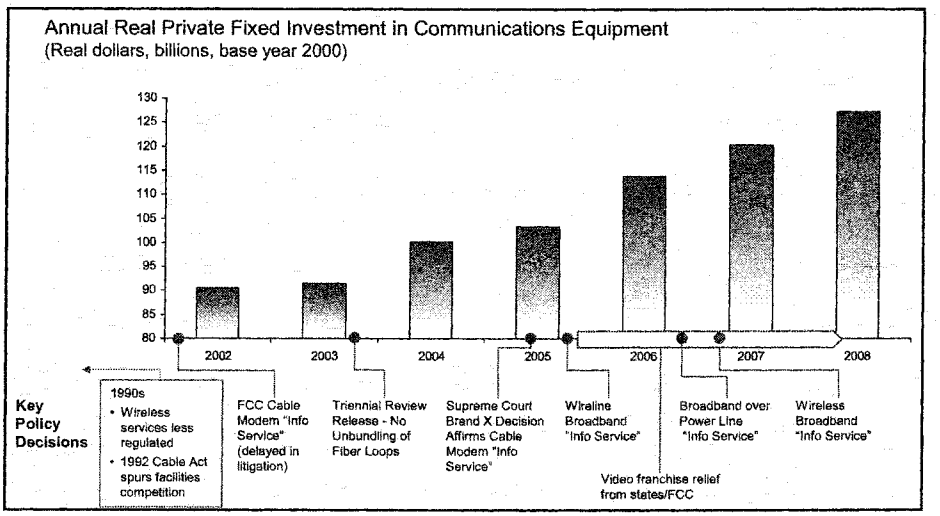
[39] Press Release, U.S. Department of Labor, BLS, Productivity and Costs: Fourth Quarter and Annual Averages, 2008 Revised (Mar. 5, 2009), *available at* http://www.bls.gov/news.release/prod2.nr0.htm.

Broadband supports the entire ICT sector and recent broadband policy decisions have helped spur healthy broadband investment. Policies have encouraged competing facilities-based providers to deploy broadband with private capital by moving to greater parity among broadband providers and choosing a monitoring and enforcement approach to protecting consumers rather than prescriptive mandates. In addition, policymakers have begun to break down barriers, encouraging entry into nontraditional markets. Where necessary, policy has turned to public-private partnerships or public investment, such as the recent broadband mapping and stimulus programs. Figure 16 shows that real growth in broadband and communications equipment investment in the last half decade coincided with a series of pro-competition and pro-investment policy decisions.

Any proposed change to current policies bears a heavy burden to demonstrate how that change could improve sector performance and to carefully account for the affects on jobs, growth and innovation as that change ripples through the ICT ecosystem. The risks involved in upsetting the balance that has produced the ICT record of economic success over the last several years should give pause to any policymaker considering changing course. Rather, policy should maintain a positive climate of ICT industry and consumer-driven investment, innovation and growth.

Figure 16: Real Investment Growth for Communications Equipment [40]



V
CONCLUSIONS

ICT is a rapidly integrating, innovative sector requiring broad economic and policy perspectives. ICT industry players increasingly rely on each other to generate new value for consumers. At the same time, ICT industries are competing across traditional industry boundaries, bringing competitive discipline to the innovative process.

The sector has become a major engine of economic output and growth. ICT contributed $902 billion in GDP in 2007 – among the top contributing sectors in the U.S. economy and the primary driver of real, inflation-adjusted growth.

The U.S. depends on ICT to facilitate participation in the global information economy. U.S. industries invested $455 billion in ICT investment in 2008, representing 22% of total investment. Broadband providers alone invested over $64 billion in 2008. Annual network infrastructure investment is up over 30% since 2003. In addition to

[40] BEA, NIPA Table 5.5.6U Real Private Fixed Investment in Equipment and Software by Type, *available at* http://www.bea.gov/national/nipaweb/nipa_underlying/SelectTable.asp. FCC decisions are available at www.fcc.gov.

investment non-ICT sectors used $617 billion in ICT inputs to their production in 2007.

ICT investment and usage yields substantial economic benefits. Consumer ICT spending of $545 billion has been shifting to an increasing volume of innovative technologies and communications services, for a stable-to-declining share of income. ICT provides at least ten million jobs in ICT industries and across the economy (based on 2007 data). Economists have estimated that at least one-third, and likely more of ongoing productivity growth is attributable to ICT. The impact of productivity is to raise incomes, generate economic growth, and enhance U.S. global competitiveness.

The pro-competition and pro-investment environment of recent years has, bolstered the U.S. economy and generated hundreds of billions in investment, innovation, and consumer benefits. Any change to current policies bears a heavy burden to demonstrate how that change could improve sector performance and to carefully account for the affects on jobs, growth and innovation as that change ripples through the ICT ecosystem. Policy should maintain a positive climate of ICT industry and consumer-driven investment, innovation, and growth.

APPENDIX

A. Measuring Economic Output

For the purposes of the analysis, we used the most common measure of economic output, Gross Domestic Product (GDP), as our foundation. Economists measure GDP as economic output for a period, such as a year, in three ways:

- Value Added: The value of gross output, i.e., the sum of total sales receipts across the economy, less the value of intermediate goods and services used as inputs to production.

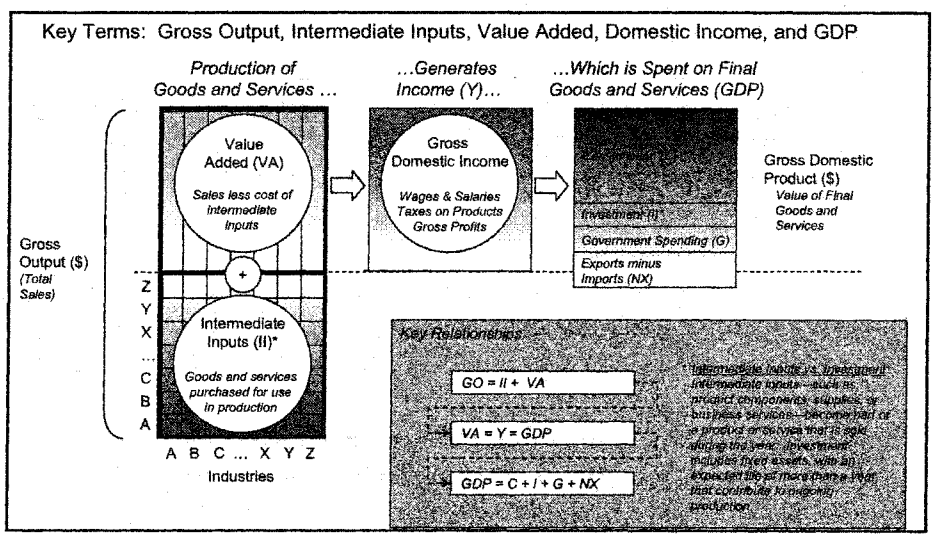
- Income: The sum of employee compensation, taxes on production and imports less subsidies, and gross operating surplus, which is a measure of corporate profitability.

- Expenditures: The sum of the value of "final" expenditures by consumers, businesses, and governments.

Figure 17 is a simple depiction of the key terms and relationships between these three measures.[41]

[41] *See* BEA, *Concepts and Methods of the U.S. National Income and Product Accounts*, Introductory Chapters 1 4 (July 2008), *available at* http://www.bea.gov/national/pdf/NIPAhandbookch1-4.pdf (explaining in detail different methods of measuring GDP).

Figure 17: Measuring GDP



The latter two approaches listed are expressed in the familiar macroeconomic equation, which states that GDP equals income (Y) which equals final expenditures, consisting of personal consumption (C), private investment (I), government spending (G), and the net of exports less imports (NX). We can extend the equation to value added (VA), expressing the relationship as GDP = Y = C + G + I + NX = VA.

When measuring GDP, economists exclude intermediate goods and services purchased as inputs to production since their value is already included in the sale of the final product. Investment, on the other hand, is considered a final purchase and is included as part of GDP. This is because investment consists of fixed assets that have useful lives of more than a year and contribute to future production.

We use U.S. Department of Commerce, Bureau of Economic Analysis (BEA) data. Specifically, we use the Annual Industry Accounts for value added measures of GDP, which are appropriate for comparing ICT and other industries. We use the National Income and Product Accounts for expenditure and income measures of GDP, which offer a useful context for ICT consumption and investment. The Annual Industry Accounts are current through 2007 and the National Income and Product Accounts are current through 2008.

To put GDP numbers in context, using the value-added approach, gross output for 2007 was $25.809 trillion. After subtracting intermediate inputs of $12.001 trillion, value added, or GDP, for 2007 was $13.806 trillion. At the time of the writing of this paper, 2008 data for the value added approach were not available. However, using the expenditures approach, we know U.S. GDP in 2008 was $14.265 trillion, consisting of the following components:[42]

- $10.057 trillion in personal consumption expenditures (PCE).
- $1.995 trillion in gross private investment, consisting of $2.041 in fixed private investment, offset by a $46 billion decline in private inventories.
- $2.883 trillion in government spending, consumption plus investment.
- An offset of $671 billion for the net of exports ($1.861 trillion) minus imports ($2.532 trillion).

[42] *See* NIPA Table 1.1.5, *supra* note 10.

B. ICT-Centric Occupation List

The employment analysis is based on U.S. Bureau of Labor Statistics, Occupations Employment Statistics 2007.[43] In our analysis, the following occupations were classified as ICT-centric.

- Advertising and promotions managers
- Advertising sales agents
- Archivists
- Audio-visual equipment technicians
- Audio-visual collection specialists
- Broadcast news analysts
- Broadcast technicians
- Camera and photographic equipment repairers
- Camera operators, television, video, and motion picture
- Communications equipment operators, all other
- Communications teachers, postsecondary
- Computer and information scientists, research
- Computer and information systems managers
- Computer hardware engineers
- Computer operators
- Computer programmers
- Computer science teachers, postsecondary
- Computer software engineers, applications
- Computer software engineers, systems software
- Computer support specialists
- Computer systems analysts
- Computer specialists, all other
- Computer, automated teller, and office machine repairers
- Data entry keyers
- Database administrators
- Desktop publishers
- Electrical and electronic equipment assemblers
- Electronic equipment installers and repairers, motor vehicles
- Electronic home entertainment equipment installers and repairers
- Film and video editors
- Graphic designers
- Job Printers
- Librarians
- Library assistants, clerical
- Library science teachers, postsecondary
- Library technicians
- Media and communication equipment workers, all other
- Media and communication workers, all other
- Motion picture projectionists
- Network and computer systems administrators
- Network systems and data communications analysts
- Radio and television announcers
- Radio mechanics
- Radio operators
- Retail sales for ICT-associated products and services (electronics and communications equipment, content)
- Security and fire alarm systems installers
- Semiconductor processors
- Sound engineering technicians
- Switchboard operators, including answering service
- Telecommunications equipment installers and repairers, except line installers
- Telecommunications line installers and repairers
- Telemarketers
- Telephone operators
- Word processors

[43] Occupational Employment Statistics (4-digit NAICS), *supra* note 32.

C. Productivity Impact Estimate

We conservatively look only at the non-farm business sector, ignoring farms (a small portion of output) and housing (mostly imputed rents). Real GDP for the non-farm business sector grew 0.8% from $9.128 trillion in 2007 to $9.199 trillion in 2008.[44] Productivity for the non-farm business sector grew 2.8%, meaning real GDP would have fallen 2% without the productivity growth.[45] It follows that without productivity, real GDP for the non-farm business sector would have been $8.943 trillion. To get the nominal productivity impact, we need to convert to nominal dollars and compare to nominal GDP for the period. To convert to nominal dollars, for the sake of simplicity, we assume that the ratio of nominal to real GDP is the same before and after the productivity adjustment. Nominal non-farm business GDP was 10.917 billion in 2008, and real non-farm business GDP was 84.3% of that. Dividing $8.943 trillion by 84.3%, we get a nominal non-farm business GDP of $10.614 trillion *without the productivity impact.* Subtracting from actual non-farm business GDP of $10.917 trillion, we get a productivity impact of roughly $300 billion. We now attribute some portion of this productivity impact to ICT. Based on economic studies that allocated productivity growth to ICT in the 2000 to 2005/6 period[46] we could speculate by extrapolating from the past that a third of the 2008 productivity impact was attributable to ICT capital deepening and total factor productivity of ICT firms. We could further speculate that about one-third of the impact was from labor improvement and non-ICT capital deepening, i.e., not affected by ICT, and the final third was affected attributable to total factor productivity of non-ICT firms. If the ICT impact on total factor productivity of non-ICT firms were zero, the total impact of ICT would be about one-third, or $100 billion dollars. If the ICT impact on total factor productivity of non-ICT firms were half, then the total ICT impact would be about fifty percent, or $150 billion. So a range of $100 billion to $150 billion seems to be a reasonable range for our estimate.

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[44] BEA, NIPA Table 1.3.6, *available at* http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected=N (last visited Apr. 16, 2009)

[45] *See* Productivity and Costs: Fourth Quarter and Annual Averages, *supra* note 39.

[46] *See* Jorgenson et al., *supra* note 36.