

Information and Communications Technology Industries Account for \$133 Billion of Business R&D Performance in the United States in 2013

by Brandon Shackelford and John Jankowski¹

Information and communications technologies (ICTs) have grown to be pervasive throughout the economy, and companies that develop these technologies account for a large share of business R&D expenditures in the United States. According to the Business R&D and Innovation Survey (BRDIS), of the \$323 billion of research and development performed by companies in the United States in 2013, ICT industries accounted for 41% (\$133 billion) (table 1). For perspective, R&D expenditures of ICT industries is 2.5 times larger than the pharmaceutical manufacturing industry, the single largest industry in terms of R&D expenditures in the United States.²

Defining the ICT Sector

For this InfoBrief the ICT sector is defined as the sum of ICT manufacturing, which comprises North American Industrial Classification System (NAICS) 334 (computer and electronic products), and ICT services, which comprises NAICS 5112 (software publishers), NAICS 517 (telecommunications), NAICS 518 (data processing, hosting, and related services), NAICS 5415 (computer systems design and

related services), and the remaining industries within NAICS 51 (information) other than traditional paper publishers. This definition is generally comparable to that used by the Organization for Economic Cooperation and Development (OECD), which defines the ICT sector using the International Standard Industrial Classification (ISIC) (OECD 2011).³

These groupings are a useful proxy, but they exclude some companies and industries that might otherwise be considered ICT companies. For example, companies that provide financial services or travel services via the Internet are classified with the more traditional companies providing those services in the NAICS methodology.

International Comparisons of ICT Business R&D

The ICT sector's share of total business R&D performance is higher in the United States than in most other economies. Of the 36 economies with business R&D data tracked by the OECD, in only four (Taiwan, South Korea, Finland, and Israel) do ICT

industries account for a larger share of business R&D than in the United States (figure 1). In both Taiwan and South Korea, ICT manufacturing industries account for over half of each economy's business R&D performance. In Israel, ICT services industries are estimated to have performed over twice as much R&D as ICT manufacturing industries. Other economies where R&D in ICT services exceeded that of ICT manufacturing include Ireland, Canada, and the United Kingdom. In the United States, the ICT manufacturing and ICT services industries performed roughly the same amount of R&D, accounting for 20.8% and 20.5%, respectively, of business R&D performance in 2013. ICT industries are estimated to have accounted for less than 20% of China's business R&D in 2013.⁴

Growth of ICT R&D in the United States

The preceding analysis comparing international R&D expenditures included business R&D performance that was paid for by companies out of their own budgets as well as by companies' customers and business partners. In the United States, a large share of the

TABLE 1. Expenditures for business R&D performed in the United States, by source of funds and selected industry: 2013
(Millions of U.S. dollars)

Industry and NAICS code	All R&D	Paid for by the company	Paid for by others
All industries, 21–33, 42–81	322,528	264,913	57,615
ICT industries, 334, 51 (part), 5415	133,339	121,169	12,170
ICT manufacturing (computer and electronic products), 334	67,205	57,364	9,841
Communications equipment, 3342	15,658	13,693	1,964
Semiconductor and other electronic components, 3344	30,800	28,576	2,224
Navigational, measuring, electromedical, and control instruments, 3345	14,478	9,001	5,477
Other computer and electronic products, other 334	6,269	6,093	176
ICT services, 51 (part), 5415	66,134	63,805	2,329
Software publishers, 5112	35,333	34,296	1,037
Telecommunications, 517	3,041	3,037	4
Data processing, hosting, and related services, 518	6,446	6,333	113
Other ICT information, other 51 ^a	12,046	12,032	14
Computer systems design and related services, 5415	9,268	8,107	1,161
Non-ICT industries	189,189	143,743	45,446
Food manufacturing, 311	5,028	4,801	227
Pharmaceuticals and medicines, 3254	52,426	45,891	6,534
Automobiles, bodies, trailers, and parts, 3361–63	16,729	14,081	2,647
Aerospace products and parts, 3364	27,114	10,042	17,072
Medical equipment and supplies, 3391	10,954	10,638	317
Manufacturing nec, other 31–33	42,020	38,353	3,668
Nonmanufacturing nec, other 21–23, 42–81	34,918	19,937	14,981

i = more than 50% of value imputed.

ICT = information and communications technologies; NAICS = North American Industry Classification System; nec = not elsewhere classified.

^a Includes a small amount of non-ICT R&D from the motion picture and sound recording industries (NAICS 512) and broadcasting industries (NAICS 515).

NOTES: Detail may not add to total because of rounding. Statistics are representative of companies located in the United States that performed or funded R&D. Industry classification was based on dominant business code for domestic R&D performance, where available. For companies that did not report business codes, the classification used for sampling was assigned. Excludes data for federally funded research and development centers.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, Business R&D and Innovation Survey, 2013.

R&D paid for by companies' customers and business partners is funded by the federal government and is concentrated in defense-related industries, such as aerospace manufacturing. This explains why the ICT share of business R&D that was paid for by sources other than the performing companies was relatively low, at 21%, in 2013 (table 1). In terms of only the R&D that is both paid for and performed by the same companies, the ICT sector accounted for 46% of the \$265 billion of R&D performed in the United States in 2013. This share has grown from 42% in 2008 (figure

2). Growth in ICT R&D has been most evident in the ICT services industries, which accounted for 20% of the \$233 billion of R&D paid for and performed by companies in the United States in 2008 and 24% of the \$265 billion of R&D in 2013. The R&D performed by the ICT services industries grew from an estimated \$45.3 billion in 2008 to \$63.8 billion in 2013.

Cost Structure of R&D in ICT Industries

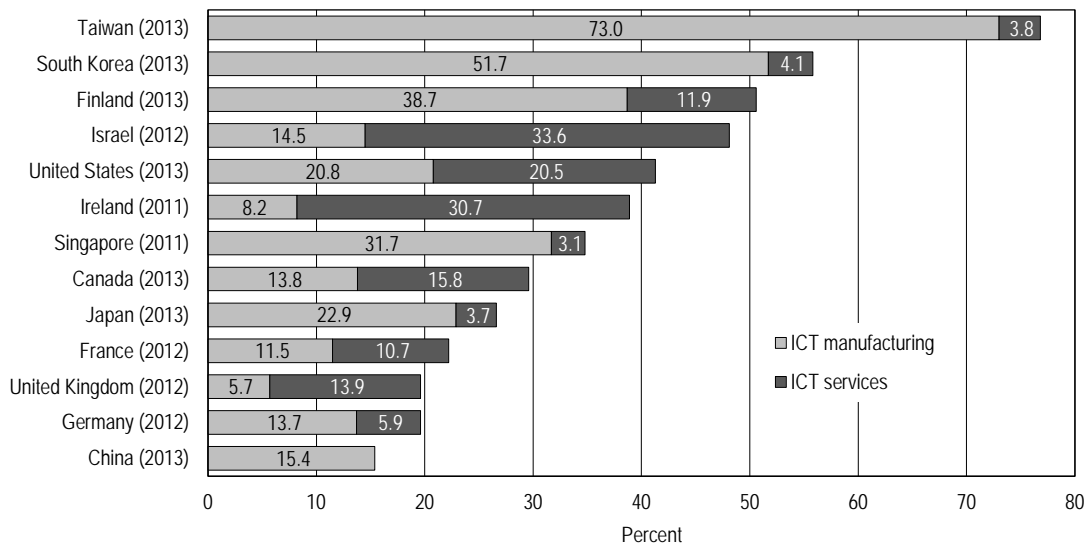
BRDIS asks companies to report the various types of costs that make up

their R&D expenditures. These cost categories include labor costs (which include salaries and wages, fringe benefits, and stock-based compensation of employees, as well as temporary staffing costs, including on-site consultants), extramural R&D (the amount the company pays other parties, such as contract research organizations, to perform R&D), and other intramural costs (which include, for example, materials and supplies, rent, expensed equipment, and depreciation).

ICT industries have some of the most labor-intensive R&D in the United States (figure 3). Labor costs accounted for 76% and 67% of domestic R&D expenditures paid for by ICT services and ICT manufacturing industries, respectively, in 2013. The comparable statistic for the entire U.S. business sector was 60%. In contrast to the ICT industries, the aerospace products and parts industry and the pharmaceuticals and medicine industry are each estimated to spend less than 40% of their domestic R&D expenditures on labor costs. These two industries also spend relatively more than ICT industries on extramural R&D.

Within the ICT sector, the computer systems design and related services industry (NAICS 5415) is estimated to have the most labor-intensive R&D, with labor costs accounting for 83% of its domestic R&D expenditures (figure 3). Labor costs account for 80% of R&D in the "other ICT information" industry, which is dominated by companies in the Internet publishing and broadcasting and Web search portals industry (NAICS 519130). The communications equipment industry (NAICS 3342), which includes makers of line-based communications equipment such as routers, as well as makers of wireless communications equipment has labor costs estimated as almost two thirds (65%) of its domestic R&D expenditures in 2013. Nonetheless, the

FIGURE 1. ICT share of business R&D, by selected economy: 2013 or most recent year



ICT = information and communications technologies; ISIC = International Standard Industry Classification.

NOTES: ICT manufacturing comprises ISIC 26 (computer, electronic, and optical products). ICT services comprises ISIC 582 (software publishing), ISIC 61 (telecommunications), and ISIC 62–63 (IT and other information services) except for Finland, Germany, Israel, and Japan where lack of detail necessitated the use of ISIC 58–63 (information and communication). ICT services data for China were last available in 2009 when it represented 3.7% of China’s business R&D.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, Business R&D and Innovation Survey, 2013. Organisation for Economic Co-operation and Development, ANBERD database, http://stats.oecd.org/Index.aspx?DataSetCode=ANBERD_REV4, accessed 16 September 2015.

communications equipment industry is one of the least labor-intensive ICT industries.

Software R&D in U.S. Businesses

Software is no longer the sole province of traditional ICT companies and is of growing importance to a wide range of industries (Kirkpatrick 2011). BRDIS data on the technology focus of companies’ R&D confirm that software R&D—R&D for software products or software embedded in other projects or products—is performed by companies in a wide range of industries. Indeed, the ICT industries account for less than half the total number of companies estimated to perform software R&D in 2013 (table 2).⁵

Almost half (49%) of the companies performing their own R&D in the

United States are estimated to have performed software R&D, and this software R&D is estimated to account for 33% of all domestic R&D paid for and performed by companies in 2013 (table 2). For the nonmanufacturing industries, it is estimated to account for 74% of company R&D. Even after excluding the information industry (NAICS 51), the remaining nonmanufacturing industries are estimated to devote about half (52%) of their domestic R&D to software R&D.

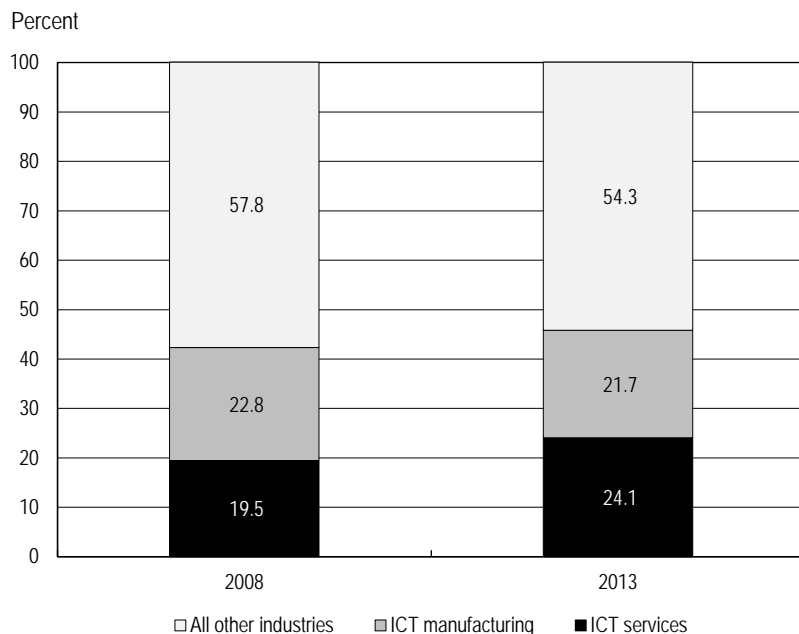
As a share of total R&D, software R&D is much smaller for the manufacturing industries, accounting for 14% of R&D paid for and performed by companies. Within the ICT manufacturing industries, software R&D is relatively smaller in the semiconductor manufacturing industry (NAICS 3344) (24% of domestic R&D performance) than

in the other ICT manufacturing industries (44%). The relatively low amount of software R&D (3% of U.S. R&D performance) estimated in the automobile manufacturing industries (NAICS 3361–63) at first seems at odds with the increasing integration of ICT in automobiles, but it is perhaps indicative of these industries’ use of software developed by third parties in their products (Newcomb 2012), and software R&D may be captured in part in their extramural R&D funding totals (figure 3).

Data Sources and Limitations

The sample for BRDIS was selected to represent all for-profit, nonfarm companies that are publicly or privately held and have five or more employees in the United States. Estimates produced from the survey and presented in this InfoBrief are restricted to companies that

FIGURE 2. ICT share of U.S. business R&D paid for by the performing company: 2008 and 2013



ICT = information and communications technologies; NAICS = North American Industry Classification System.

NOTES: ICT manufacturing comprises NAICS 334 (computer and electronic products) and ICT services comprises NAICS 5112 (software publishers), NAICS 517 (telecommunications), NAICS 518 (data processing, hosting, and related services), NAICS 5415 (computer systems design and related services), and the remaining industries within NAICS 51 (information) other than traditional paper publishers.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, Business R&D and Innovation Survey.

perform or fund R&D, either domestically or abroad. Because the statistics from the survey are based on a sample, they are subject to both sampling and nonsampling errors (see technical notes in the survey's detailed statistical tables at <http://www.nsf.gov/statistics/industry/>).

In this InfoBrief, money amounts are expressed in current U.S. dollars and are not adjusted for inflation. Company is defined as a business organization located in the United States, either U.S. owned or a U.S. affiliate of a foreign parent, of one or more establishments under common ownership or control that performs or funds R&D.

For 2013, a total of 45,089 companies were sampled, representing 1,971,959 companies. The actual numbers of reporting units in the sample that remained within the scope of the survey between sample selection and tabulation were 41,588 for 2013. Reasons for the reduced counts include mergers, acquisitions, and instances where companies had fewer than five paid employees in the United States or had gone out of business in the interim. Of these in-scope reporting units, 73.6% met the 2013 survey response criteria. Industry classification was based on the dominant business activity for domestic R&D performance where available.

For reporting units that did not report business activity codes for R&D, the classification used for sampling was assigned.

The full set of detailed tables from this survey will be available in the report *Business R&D and Innovation: 2013* (<http://www.nsf.gov/statistics/industry/>). Individual detailed tables and tables with relative standard errors and imputation rates from the 2013 survey will be available in advance of the full report. For further information concerning the BRDIS survey, contact Raymond M. Wolfe at rwolfe@nsf.gov; 703-292-7789.

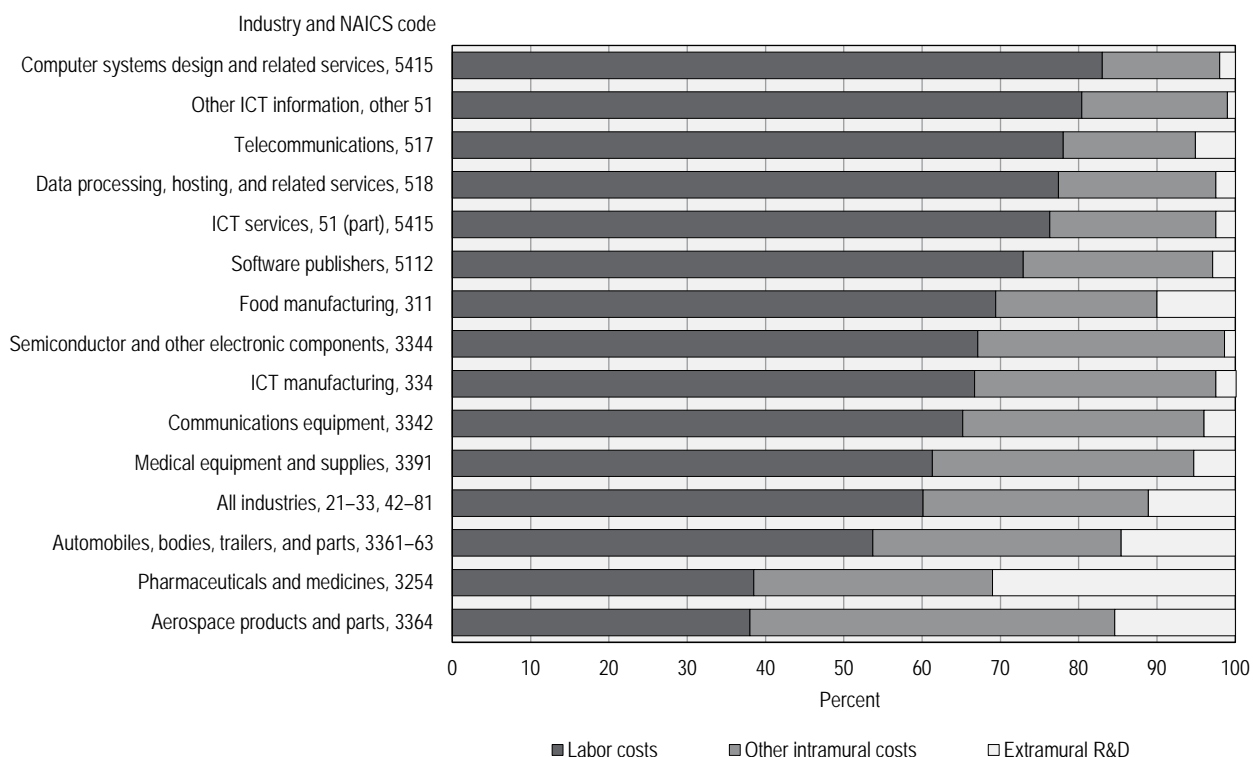
Notes

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2. Not all R&D performed by businesses classified in ICT industries is for developing information and communications technologies. Also, some ICT-related R&D is undertaken within businesses that are not part of the ICT sector.

3. The corresponding ISIC-based definition for the ICT sector would be the sum of ICT manufacturing, which comprises ISIC 26 (manufacture of computer, electronic and optical products), and ICT services, which comprises ISIC 582 (software publishing), ISIC 61 (telecommunications), and ISIC 62–63 (IT and other information services). The OECD ICT sector definition also includes ISIC 4651–2 (wholesale of ICT equipment, software and parts) and ISIC 951–2 (repair of computers and communi-

FIGURE 3. Cost structure of domestic R&D expenditures paid for by companies, by selected industry: 2013



ICT = information and communications technologies; NAICS = North American Industry Classification System.

NOTES: Labor costs comprises salaries and wages, fringe benefits, and stock-based compensation of employees and temporary staffing costs, including on-site consultants. Extramural R&D is the portion of R&D costs the company pays other parties, such as contract research organizations, to perform R&D. The "other ICT information" industry includes a small amount of non-ICT R&D from the motion picture and sound recording industries (NAICS 512) and broadcasting industries (NAICS 515). Over 50% of the type of cost data for the telecommunications industry was a combination of imputation and reweighting to account for nonresponse.

SOURCES: National Science Foundation, National Center for Science and Engineering Statistics and U.S. Census Bureau, Business R&D and Innovation Survey, 2013.

cation equipment), neither of which contribute much to national R&D estimates. (See OECD 2011, Annex 7.A1.)

4. ICT services are not broken out in China's data after 2009, but total services accounted for 6.3% of China's business R&D total in 2012.

5. Statistics for number of companies are based only on companies in the United States that reported to the survey. These statistics do not include

an adjustment to the weight to account for unit nonresponse.

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TABLE 2. Software R&D in companies with domestic R&D paid for and performed by the company, by select industry: 2013
(Millions of U.S. dollars)

Industry and NAICS code	Total domestic R&D		Software R&D			Percent of domestic R&D
	Companies ^a (number)	Amount	Companies ^a (number)	Companies ^a (percent)	Amount	
All industries, 21–33, 42–81	65,139	264,913	31,681	49	87,245	33
Manufacturing industries, 31–33	27,655	181,170	15,241	55	24,956	14
Pharmaceuticals and medicines, 3254	906	45,891	421	46	401	1
Semiconductor machinery, 333295	162	3,097	154	95	468	15
Computer and electronic products, 334	3,944	57,364	3,552	90	19,624	34
Semiconductor and other electronic components, 3344	1,305	28,576	1,201	92	6,954	24
Other computer and electronic products, other 334	2,640	28,788	2,352	89	12,670	44
Electrical equipment, appliances, and components, 335	1,143	3,660	1,042	91	694 i	19
Transportation equipment, 336	1,948	25,165	1,156	59	1,156	5
Automobiles, bodies, trailers, and parts, 3361–63	1,212	14,081	906	75	419	3
Other transportation, other 336	736	11,084	250	34	736	7
Other manufacturing nec, other 31–33	19,558	45,993	8,917	46	2,614 i	6
Nonmanufacturing industries, 21–23, 42–81	37,486	83,742	16,440	44	62,289	74
Mining, extraction, and support activities, 21	246	3,602	149	61	330	9
Information, 51	3,890	56,039	3,020	78	47,791	85
Publishing, 511	2,055	34,637	1,611	78	29,562	85
Telecommunications, 517	231	3,037	130	56	2,133 i	70
Data processing, hosting, and related services, 518	1,015	6,333	969	95	5,327	84
Other information, other 51	589	12,032	310	53	10,769	90
Professional, scientific, and technical services, 54	12,693	15,617 i	10,041	79	8,993 i	58
Architectural, engineering, and related services, 5413	2,074	1,261	1,753	85	131 i	10
Scientific research and development services, 5417	1,320	2,838	615	47	203 i	7
Other professional, scientific, and technical services, other 54	9,300	11,518 i	7,673	83	8,659 i	75
Other nonmanufacturing nec, other 21–23, 42–81	20,656	8,484	3,230	16	5,175	61

i = > 50% of the estimate is a combination of imputation and reweighting to account for nonresponse.

NAICS = North American Industry Classification System; nec = not elsewhere classified.

^a Statistics for number of companies are weighted estimates based on only companies that reported to the survey. No adjustment is made to account for unit nonresponse.

NOTES: Software R&D includes R&D for software products and for software embedded in other projects or products. Detail may not add to total because of rounding. Industry classification based on dominant business code for domestic R&D performance where available. For companies that did not report business codes, classification used for sampling was assigned.

SOURCE: National Science Foundation, National Center for Science and Engineering Statistics, and U.S. Census Bureau, Business R&D and Innovation Survey, 2013.

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