Research and Development Satellite Account Update

Estimates for 1959–2004

New Estimates for Industry, Regional, and International Accounts

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THE Bureau of Economic Analysis-National Science Foundation (BEA-NSF) research and development (R&D) satellite account provides detailed statistics designed to facilitate research into the effects of R&D on the economy. The account shows how gross domestic product (GDP) and other measures would be affected if R&D spending were "capitalized," that is, if R&D spending were treated as investment rather than as an expense.

The most recent R&D satellite account, released in September, updates the statistics released last year and offers additional data for 2 more years (2003–2004). The R&D account also provides for the first time, R&D statistics for R&D-intensive industries, regional accounts, and international accounts. In addition, the updated R&D account reflects several improvements to estimation methods.

The R&D account was developed with support from NSF's Division of Science Resource Statistics, which is responsible for national R&D statistics. According to the updated R&D account estimates, treating R&D spending as investment would have a significant effect on BEA's measures of the economy:

- The contribution to real GDP growth from treating R&D as investment would have been approximately 0.2 percentage point of the 3.3-percent growth, or about a 7-percent share of the growth rate in 1995–2004 (table D).
- The level of current-dollar gross domestic product (GDP) would have been an average 2.9 percent higher between 1959 and 2004. (For background, see the box "How R&D Affects GDP and GDI" on page 62.)
- Current-dollar R&D investment would have been $316.6 billion in 2004, an increase of 5.7 percent from the $299.6 billion in 2003 (table A).
- Current-dollar gross private domestic investment in 2004 would have been 8.8 percent, or $166.3 billion, higher than published gross private domestic investment. This measure removes the double-counting of R&D expenditures in software investment. The national saving rate in 2004 would rise 2.0 percentage points to 15.8 percent (table B).
- The largest contribution from R&D intensive industries to real GDP growth rates for 1995–2004 would have been from the pharmaceutical and medicine manufacturing industry (table D). This industry's contribution would have accounted for more than a 1-percent share of the real GDP growth rate. The software publishing industry would have accounted for an additional 0.5-percent share.
- The level of GDP by state would have increased the most for New Mexico (8.2 percent) and for Maryland (6.2 percent) between 1998 and 2002 (table F).
- The level of value added of majority-owned foreign affiliates of U.S. multinational companies (MNCs) would have risen $25.9 billion, or 3.1 percent, in 2004 (table G). The value added of majority-owned U.S. affiliates of foreign MNCs would have grown $28.1 billion, or 5.5 percent. For U.S. parent companies, value added would have risen $148.2 billion, or 6.7 percent.

Currently, the national economic accounts do not treat R&D and many other intangibles as investment and thus cannot separately identify their contribution to U.S. economic growth. BEA's R&D account is part of BEA's long-term efforts to better account for intangible assets. (See the box "The Broader World of Innovation" on page 63.)

The R&D satellite account format provides a means of exploring the impact of adjusting the treatment of R&D activity on the economy and a framework through which various methodological and conceptual issues can be worked out. The R&D account can be seen as prelude toward adjusting BEA's core economic accounts to better account for R&D. Currently, BEA plans to incorporate R&D spending as investment into its core accounts around 2013.

This rest of this report is organized as follows. First, the enhancements made to the R&D account this year

G. Andrew Bernat contributed the section on regional R&D estimates, and Daniel R. Yorgason contributed the section on international R&D estimates.

are described. Second, the impact of the updated estimates on the national income and product accounts (NIPAs) are explained, and revisions to previous R&D estimates are discussed. Third, the new estimates for 13 R&D-intensive industries are described. Fourth, first-time estimates of the effect of R&D investment on GDP by state and on the international accounts are discussed.

Table A. GDP and the Decomposition of the Adjustments to GDP With R&D Treated as Investment—Continues

[Billions of dollars]

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
GDP (from the NIPAs)	**506.6**	**526.4**	**544.7**	**585.6**	**617.7**	**663.6**	**719.1**	**787.8**	**832.6**	**910.0**
2006 vintage R&D satellite account:										
Total adjustments to GDP from R&D investment	10.8	11.6	12.0	12.9	14.3	16.1	18.2	20.9	23.3	26.5
Business	5.8	5.8	5.3	4.8	4.8	5.0	5.2	6.0	6.7	8.2
Government	4.8	5.6	6.6	7.9	9.2	10.9	12.8	14.7	16.3	17.9
Nonprofit institutions serving households	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3
GDP with R&D treated as investment	517.4	538.0	556.8	598.5	632.0	679.8	737.3	808.7	855.9	936.5
Percent change in the level of GDP	2.1	2.2	2.2	2.2	2.3	2.4	2.5	2.7	2.8	2.9
2007 vintage R&D satellite account:										
Total adjustments to GDP from R&D investment	11.1	12.5	13.8	15.4	17.0	19.1	21.5	23.9	26.1	28.6
Business	4.2	4.6	4.9	5.2	5.6	6.1	6.7	7.5	8.4	9.3
Government	6.8	7.7	8.8	10.0	11.2	12.8	14.5	16.1	17.4	19.0
Nonprofit institutions serving households	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3
GDP with R&D treated as investment	517.7	538.9	558.5	601.1	634.8	682.7	740.6	811.7	858.7	938.6
Percent change in the level of GDP	2.2	2.4	2.5	2.6	2.8	2.9	3.0	3.0	3.1	3.1
GDP with R&D and software adjustments [1]	517.7	538.9	558.5	601.1	634.8	682.7	740.6	811.7	858.7	938.6
Percent change in the level of GDP	2.2	2.4	2.5	2.6	2.8	2.9	3.0	3.0	3.1	3.1
Addenda:										
R&D investment (2007 vintage) [2]	13.9	15.3	16.1	17.2	19.2	20.9	22.3	24.4	25.8	27.2

	1969	1970	1971	1972	1973	1974	1975	1976	1977
GDP (from the NIPAs)	**984.6**	**1,038.5**	**1,127.1**	**1,238.3**	**1,382.7**	**1,500.0**	**1,638.3**	**1,825.3**	**2,030.9**
2006 vintage R&D satellite account									
Total adjustments to GDP from R&D investment	29.3	30.5	32.0	34.0	36.6	38.9	42.2	46.7	50.9
Business	10.0	10.4	10.6	11.7	13.2	14.7	15.6	17.6	19.5
Government	18.9	19.8	21.0	21.9	22.8	23.7	26.0	28.4	30.6
Nonprofit institutions serving households	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8
GDP with R&D treated as investment	1,013.9	1,069.1	1,159.1	1,272.3	1,419.3	1,538.9	1,680.6	1,872.0	2,081.8
Percent change in the level of GDP	3.0	2.9	2.8	2.7	2.6	2.6	2.6	2.6	2.5
2007 vintage R&D satellite account									
Total adjustments to GDP from R&D investment	30.7	31.9	33.8	35.9	38.7	43.4	48.4	52.3	56.7
Business	10.3	10.8	11.2	12.1	13.8	15.5	16.6	18.6	20.6
Government	20.0	20.7	22.2	23.3	24.4	27.2	31.1	32.9	35.3
Nonprofit institutions serving households	0.4	0.4	0.4	0.5	0.5	0.6	0.7	0.8	0.9
GDP with R&D treated as investment	1,015.3	1,070.5	1,161.0	1,274.2	1,421.4	1,543.3	1,686.7	1,877.5	2,087.7
Percent change in the level of GDP	3.1	3.1	3.0	2.9	2.8	2.9	3.0	2.9	2.8
GDP with R&D and software adjustments [1]	1,015.3	1,070.5	1,161.0	1,274.2	1,421.4	1,543.3	1,686.7	1,877.5	2,087.7
Percent change in the level of GDP	3.1	3.1	3.0	2.9	2.8	2.9	3.0	2.9	2.8
Addenda:									
R&D investment (2007 vintage) [2]	28.4	28.6	29.4	31.4	33.8	36.5	39.1	43.1	47.2

	1978	1979	1980	1981	1982	1983	1984	1985	1986
GDP (from the NIPAs)	**2,294.7**	**2,563.3**	**2,789.5**	**3,128.4**	**3,255.0**	**3,536.7**	**3,933.2**	**4,220.3**	**4,462.8**
2006 vintage R&D satellite account:									
Total adjustments to GDP from R&D investment	55.3	61.4	68.0	77.6	87.1	96.1	107.5	116.5	120.2
Business	22.5	27.0	31.7	37.7	43.4	49.7	57.7	64.1	64.3
Government	32.0	33.5	35.2	38.7	42.3	44.9	48.2	50.7	53.9
Nonprofit institutions serving households	0.9	1.0	1.1	1.2	1.4	1.5	1.7	1.8	2.0
GDP with R&D treated as investment	2,350.1	2,624.8	2,857.5	3,206.0	3,342.1	3,632.8	4,040.7	4,336.8	4,583.0
Percent change in the level of GDP	2.4	2.4	2.4	2.5	2.7	2.7	2.7	2.8	2.7
2007 vintage R&D satellite account:									
Total adjustments to GDP from R&D investment	62.9	70.6	80.6	93.3	102.1	111.4	125.4	135.8	143.4
Business	23.9	28.3	33.8	39.5	44.7	49.8	57.4	63.5	67.4
Government	38.1	41.2	45.6	52.3	55.8	59.8	66.0	70.1	73.7
Nonprofit institutions serving households	1.0	1.1	1.3	1.5	1.6	1.8	2.0	2.2	2.3
GDP with R&D treated as investment	2,357.7	2,633.9	2,870.1	3,221.7	3,357.1	3,648.1	4,058.6	4,356.0	4,606.2
Percent change in the level of GDP	2.7	2.8	2.9	3.0	3.1	3.2	3.2	3.2	3.2
GDP with R&D and software adjustments [1]	2,357.3	2,633.1	2,868.9	3,220.2	3,355.2	3,645.7	4,055.9	4,352.9	4,602.7
Percent change in the level of GDP	2.7	2.7	2.8	2.9	3.1	3.1	3.1	3.1	3.1
Addenda:									
R&D investment (2007 vintage) [2]	53.2	61.3	70.8	81.2	90.3	99.9	113.4	127.2	134.3

1. GDP with R&D treated as investment and with the double-counting of R&D software investment removed.

2. R&D investment includes spending on R&D by government and nonprofit institutions serving households, whereas the adjustment to GDP for this spending consists only of the consumption of fixed capital charges and net returns to R&D investment.

NOTE. Implemented using the aggregate output price index to estimate current-cost depreciation.

The underlying concepts and detailed computational methods for the R&D account will be provided in a series of papers that will be posted to the BEA Web site as they become available.[1]

Estimation Improvements

The updated satellite account incorporated several enhancements:

- Estimates of R&D investment were adjusted to explicitly account for international transactions.
- The valuation of the purchase price of R&D by business was improved.
- The index of estimated prices for R&D output was enhanced to better reflect the value of R&D investment to the industries that purchase or create R&D for investment purposes.
- A double-count embedded in the R&D investment and software investment estimates was eliminated.

Adjustment for international transactions

The updated R&D account's estimates of business R&D investment were improved by explicitly accounting for R&D output performed in the U.S. and used abroad and for R&D output performed abroad and used in the U.S. The adjustment added R&D imports to industry investment and subtracted the cost of R&D exports from the R&D output that each industry retains for its own use.

For this adjustment, BEA relied on exports and imports data collected by BEA on receipts and payments

1. These papers will address the construction of the price indexes for R&D investment, the detailed methodology for the satellite account, the impact of capitalization on industry rates of return, the detailed methodology for the industry estimates, the construction of the R&D stocks and depreciation rates, regional issues, and international issues.

Table A. GDP and the Decomposition of the Adjustments to GDP With R&D Treated as Investment—Table Ends

[Billions of dollars]

	1987	1988	1989	1990	1991	1992	1993	1994	1995
GDP (from the NIPAs)	**4,739.5**	**5,103.8**	**5,484.4**	**5,803.1**	**5,995.9**	**6,337.7**	**6,657.4**	**7,072.2**	**7,397.7**
2006 vintage R&D satellite account:									
Total adjustments to GDP from R&D investment	126.6	136.1	145.4	158.8	173.8	179.5	181.2	186.4	200.2
Business	66.3	70.4	73.7	81.0	89.6	90.7	88.7	90.2	104.2
Government	58.1	63.3	68.8	74.6	80.6	84.8	88.1	91.4	91.0
Nonprofit institutions serving households	2.2	2.5	2.8	3.2	3.6	4.0	4.4	4.7	4.9
GDP with R&D treated as investment	4,866.0	5,239.9	5,629.7	5,961.9	6,169.7	6,517.3	6,838.6	7,258.6	7,597.8
Percent change in the level of GDP	2.7	2.7	2.7	2.7	2.9	2.8	2.7	2.6	2.7
2007 vintage R&D satellite account:									
Total adjustments to GDP from R&D investment	150.4	162.2	173.6	179.3	190.8	196.2	198.8	203.9	215.9
Business	69.5	75.7	83.4	87.3	96.5	100.6	101.4	104.3	116.1
Government	78.4	83.7	87.2	88.7	90.7	91.7	93.2	95.1	95.0
Nonprofit institutions serving households	2.5	2.8	3.1	3.3	3.6	3.9	4.2	4.6	4.8
GDP with R&D treated as investment	4,889.9	5,266.0	5,658.0	5,982.4	6,186.7	6,533.9	6,856.2	7,276.1	7,613.6
Percent change in the level of GDP	3.2	3.2	3.2	3.1	3.2	3.1	3.0	2.9	2.9
GDP with R&D and software adjustments[1]	4,886.0	5,261.7	5,653.3	5,977.3	6,181.3	6,528.1	6,850.0	7,269.5	7,606.6
Percent change in the level of GDP	3.1	3.1	3.1	3.0	3.1	3.0	2.9	2.8	2.8
Addenda:									
R&D investment (2007 vintage)[2]	142.0	150.6	159.4	165.3	173.9	177.9	178.6	182.3	195.9

	1996	1997	1998	1999	2000	2001	2002	2003	2004
GDP (from the NIPAs)	**7,816.9**	**8,304.3**	**8,747.0**	**9,268.4**	**9,817.0**	**10,128.0**	**10,469.6**	**10,960.8**	**11,685.9**
2006 vintage R&D satellite account:									
Total adjustments to GDP from R&D investment	213.7	228.1	238.6	257.9	281.2	282.3	277.7	n.a.	n.a.
Business	116.3	128.5	140.8	157.8	179.2	179.3	170.8	n.a.	n.a.
Government	92.2	94.2	92.2	94.1	95.6	96.3	99.8	n.a.	n.a.
Nonprofit institutions serving households	5.1	5.5	5.6	6.0	6.4	6.7	7.1	n.a.	n.a.
GDP with R&D treated as investment	8,030.5	8,532.5	8,985.6	9,526.3	10,098.1	10,410.3	10,747.3	n.a.	n.a.
Percent change in the level of GDP	2.7	2.7	2.7	2.8	2.9	2.8	2.7	n.a.	n.a.
2007 vintage R&D satellite account:									
Total adjustments to GDP from R&D investment	227.4	240.8	250.3	268.3	292.0	293.4	288.6	301.3	318.1
Business	128.9	142.5	154.0	171.4	193.6	195.8	186.9	192.5	200.9
Government	93.6	93.2	91.0	91.2	92.4	91.3	94.9	101.3	109.1
Nonprofit institutions serving households	4.9	5.2	5.3	5.6	6.0	6.3	6.8	7.4	8.1
GDP with R&D treated as investment	8,044.3	8,545.2	8,997.3	9,536.7	10,109.0	10,421.4	10,758.2	11,262.0	12,004.0
Percent change in the level of GDP	2.9	2.9	2.9	2.9	3.0	2.9	2.8	2.7	2.7
GDP with R&D and software adjustments[1]	8,036.9	8,537.4	8,988.8	9,524.4	10,093.9	10,405.8	10,734.2	11,234.9	11,969.4
Percent change in the level of GDP	2.8	2.8	2.8	2.8	2.8	2.7	2.5	2.5	2.4
Addenda:									
R&D investment (2007 vintage)[2]	209.4	225.0	238.3	256.5	279.1	287.4	285.3	299.6	316.6

n.a. Not available. The 2006 R&D satellite account only presents estimates for 1959–2002.

1. GDP with R&D treated as investment and with the double-counting of R&D software investment removed.

2. R&D investment includes spending on R&D by government and nonprofit institutions serving households, whereas the adjustment to GDP for this spending consists only of the consumption of fixed capital charges and net returns to R&D investment.

NOTE. Implemented using the aggregate output price index to estimate current-cost depreciation.

for Research, Development, and Testing (RDT) services for use in the international transaction accounts.[2] Both unaffiliated trade data (trade between firms) and affiliated trade data (trade within firms) were included in the estimated values of exports and imports of R&D, as they are for the international transactions accounts in general. The net effect in 2004 was a subtraction of $2.4 billion, or 1.2 percent, from private domestic R&D investment. The adjustment was negative in all years between 1987 and 2004; however, it became less negative after 2002. Omitting an adjustment for R&D imports would underestimate domestic investment in R&D, and omitting an adjustment for the cost of R&D exports would overestimate domestic R&D investment.[3]

Prices of purchased R&D

The updated R&D account distinguishes between two types of industry investment in R&D output: Business purchases of R&D and own-account investment. Own-account R&D investment refers to the R&D output that businesses develop for their own use rather than for sale to others. BEA estimates the value of own-account investment as the sum of costs. The value of purchased R&D includes the R&D seller's margin between receipts and costs. When this information is not available from other sources, this margin is estimated using the ratio of net operating surplus to gross output for miscellaneous professional, scientific, and technical services (5412OP) from BEA's GDP-by-industry data. This adjustment was used for both business purchases from other businesses and business purchases by the Federal Government.

Improved price indexes for R&D output

The updated R&D account presents estimates of real R&D investment based on two price indexes: One is an input price index like those used in the current NIPA estimation process when no market prices are observable; the other is an output-based index that indirectly reflects the movement of R&D output prices.

Input price index. The input price index was similar to those used for government and other hard-to-measure services in the national accounts. Thus, these estimates provide a baseline against which other estimates can be evaluated. This input price index for R&D investment was based on an aggregation of detailed price indexes for the inputs used to create R&D output. Although this method is useful for estimating the impact of inflation on R&D inputs, it is less appropriate for R&D output because it rules out productivity growth; it assumes real output grows at the same rate as real inputs. Given increases in computing power and other scientific advances, some argue that R&D productivity has increased, which would make the input price approach inappropriate.

Aggregate output price indexes. The aggregate R&D output price index is a weighted average of the output prices of R&D-intensive industries. It assumes there are common factors in R&D production processes across industries. Such an index tends to average out the extreme effects of rapidly falling or rising output prices for particular products.

The aggregate output price index was constructed using a Fisher-weighted combination of the output prices of 13 R&D-intensive industries (see the section "R&D as Investment by Industry."); the index was

2. Although these data are not a perfect match for the scope of R&D activity considered investment in the satellite account, the RDT series is a close proxy. The scope of R&D activity considered investment in the R&D satellite account is that of the *Frascati Manual*, which would include testing prototypes but not routine testing. Thus, the RDT services data may include non-R&D transactions of unknown, but likely small, magnitude.

3. For the updated R&D account, BEA treated affiliated and unaffiliated trade symmetrically. An important conceptual issue for the recognition of R&D as investment in the national economic accounts is the treatment of R&D trade flows between affiliates of multinational companies and the extent to which these flows represent changes in national ownership.

Table B. Effect on Gross Private Domestic Investment and the Saving Rate With R&D Treated as Investment

	Gross private domestic investment (GPDI)					National saving rate		
	Unadjusted, from the NIPAs (billions of dollars)	Unadjusted, less R&D software double-count (billions of dollars)	Adjusted for R&D and for R&D software double-count (billions of dollars)	Effect of R&D and software adjustments		Unadjusted[1] (percent)	Adjusted (percent)	Impact (percentage points)
				On unadjusted GPDI (percent)	On GPDI less R&D software double-count (percent)			
	(a)	(b)	(c)	(c/a–1)	(c/b–1)			
1960	78.9	78.9	83.5	5.8	5.8	21.0	23.3	2.3
1970	152.4	152.4	163.2	7.1	7.1	18.6	20.7	2.1
1980	479.3	478.1	511.8	6.8	7.1	19.8	21.6	1.8
1990	861.0	855.9	943.2	9.6	10.2	16.3	18.5	2.2
2000	1,735.5	1,720.4	1,913.9	10.3	11.3	17.7	19.8	2.1
2004	1,888.6	1,854.0	2,054.9	8.8	10.8	13.8	15.8	2.0

1. As published in the national income and product accounts.
NOTE. Implemented using the aggregate output price index.

weighted according to each industry's share of annual business R&D investment. For years before 1987, detailed industry investment measures were unavailable, and the aggregate output price index was a weighted average of the top five industry R&D performers based on NSF data.

The aggregate output price index was chosen for the featured estimates. Before selecting the aggregate output price index, two alternatives were tested: (1) Detailed R&D output price indexes based on output prices for each R&D-intensive industry and (2) detailed R&D output price indexes based on a residual intangible asset price index for industry groups. Both of these indexes apply price indexes to R&D output that vary based on the price indexes of specific industries.

The residual intangible asset price index was an implementation of the net present value concept: The maximum a firm would be willing to pay for R&D investment is the gains received from using the R&D in production. This residual price index was based on a 5-year moving average of these gains, which are computed as industry gross output less the cost of labor, intermediate inputs, and capital services that have been estimated with an average return to existing capital assets. This index and the industry-specific output price indexes produced some substantive differences in the measures of real gross output and real value added at the industry level, compared with the aggregate output price index. However, at the aggregate level, each of the two alternative price indexes produced generally consistent results with the featured aggregate output price index.

The previous R&D account, released in 2006, featured a price index created with a combination of value-added prices and output prices for the four industries that performed the most R&D. The new index uses gross output prices derived mainly from Bureau of Labor Statistics (BLS) producer price indexes. The new index also includes all 13 R&D-intensive industries rather than a subset and incorporates a finer adjustment for industry weighting and updating. The estimates that result from the new price index are similar to the previous estimates.

Where Are Spillovers?

The estimates provided in this release include only the direct impact of R&D investment, that is, the direct benefit realized by the investor. These estimates do not separately identify spillovers, the benefits of R&D to firms that did not pay for the R&D. However, the Bureau of Labor Statistics (BLS) produces measures of the impact of technological change on productivity as part of its estimates of multifactor productivity for the business sector. These estimates measure spillovers directly. BLS has estimated that approximately one-fifth of the multifactor productivity residual can be attributed to R&D in recent years. These BLS estimates of the spillovers are broadly consistent with the BEA estimates of the direct impact of R&D. For more information, see <www.bls.gov/mfp/rdtable.pdf>.

Eliminating double-counting

In this R&D account, BEA eliminated a double counting of R&D expenditures contained in software investment. The NSF source data treat the cost of developing software that is marketed outside the company as an R&D activity.[4] These costs were double counted in last year's R&D account, once in R&D investment and once in software investment. For 2007, BEA has removed the amount from the software investment estimate, retaining it in R&D investment, because the R&D satellite account is designed to focus on R&D as a capitalized asset. This adjustment lowered GDP and business investment by the amount of the double-count.

For most of the 1980s and 1990s, the double count was estimated to have been about 5 to 6 percent of business funding of R&D. By 2004, it grew to 17 percent of business funding of R&D and to 43 percent of total own-account software.

R&D and the Economy

Effect on GDP and investment

If R&D were treated as investment, GDP would have grown slightly faster on average in 1959–2004 (table C). The average difference was 0.13 percentage point in

4. In the NIPAs, three types of computer software spending—prepackaged software, custom software, and own-account software—are treated as investment and thus are included in GDP. Own-account software includes all in-house software development, whether it is for software to be used exclusively for internal company operations or for software to be marketed outside the company, such as a firm developing a software program for widespread distribution.

Table C. Comparison of Changes in Average Real GDP Growth Rates

	Unadjusted[1] (percent)	Adjusted, 2007 vintage[2] (percent)	Adjusted, 2006 vintage (percent)
	(a)	(b)	(c)
1959–1973	4.20	4.33	4.28
1974–1994	3.02	3.03	3.08
1995–2002	3.25	3.40	3.39
1995–2004	3.21	3.33	n.a.
1959–2002	3.35	3.42	3.42
1959–2004	3.33	3.40	n.a.

n.a. Not available. The 2006 R&D satellite account only presents estimates for 1959–2002.
1. As published in the national income and product accounts.
2. Real GDP with R&D treated as investment and the double-counting of R&D software removed.
NOTE. Implemented using the aggregate output price index.

1959–73. The average difference narrowed to almost zero in 1974–94 before picking up again to 0.12 percentage point in 1995–2004.

The impact of treating R&D expenditures as investment can be seen by looking at the contribution of R&D to the annual real GDP growth (table D). Of the 3.7 percent growth in real GDP in 2004, the contribution of the new treatment of R&D would have been 0.17 percentage point. In 2004, the newly recognized income flows from government and nonprofit institutions serving households would have contributed 0.09 percentage point, while business investment would have contributed a smaller 0.07 percentage point. In years when economic growth slows, R&D often detracts from growth. For example, in 1975, both business and government R&D effects on the growth rate were negative. However, business and government effects sometimes offset each other. In 2002, after the technology bubble, business R&D subtracted 0.06 percentage point from growth, while government R&D added 0.06 percentage point.

Revisions

The picture of the economy presented in the revised estimates is similar to that shown by the estimates published in 2006. In the updated estimates, current-dollar investment in R&D was higher for all years; investment in R&D totaled $285.3 billion in 2002, an upward revision of $8.8 billion from the previous estimates (chart 1). Similarly, for 1959–2002, current-dollar GDP was

Table D. Contributions to and Shares of the Annual Growth Rate of Real GDP With R&D Treated as Investment—Continues

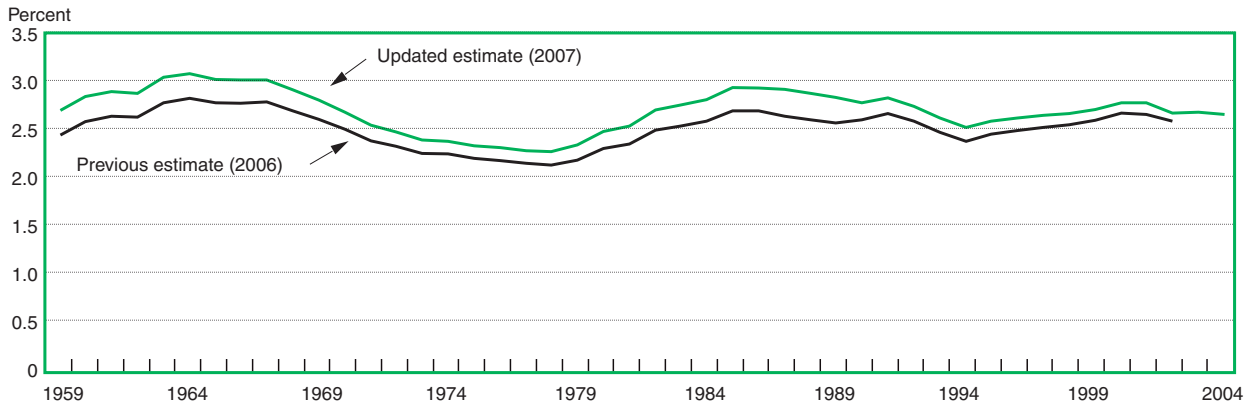
	1960	1961	1962	1963	1964	1965	1966	1967	1968
Percent change at annual rate:									
Real GDP[1]	**2.73**	**2.55**	**6.30**	**4.47**	**6.03**	**6.61**	**6.63**	**2.69**	**4.93**
Percentage points at annual rates:									
Effect of R&D as investment[2]	0.30	0.28	0.38	0.21	0.37	0.37	0.30	0.25	0.25
Business	0.09	0.05	0.07	0.06	0.07	0.09	0.10	0.08	0.08
Government	0.21	0.23	0.30	0.14	0.30	0.27	0.19	0.17	0.17
Nonprofit institutions serving households	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1969	1970	1971	1972	1973	1974	1975	1976	1977
Percent change at annual rate:									
Real GDP[1]	**3.21**	**0.20**	**3.35**	**5.32**	**5.79**	**–0.56**	**–0.30**	**5.24**	**4.56**
Percentage points at annual rates:									
Effect of R&D as investment[2]	0.22	0.03	0.08	0.18	0.18	–0.07	–0.12	0.06	0.07
Business	0.09	0.01	0.00	0.06	0.11	0.00	–0.07	0.06	0.05
Government	0.12	0.02	0.08	0.12	0.08	–0.07	–0.05	0.00	0.02
Nonprofit institutions serving households	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1978	1979	1980	1981	1982	1983	1984	1985	1986
Percent change at annual rate:									
Real GDP[1]	**5.50**	**3.12**	**–0.20**	**2.50**	**–1.83**	**4.52**	**7.19**	**4.16**	**3.45**
Percentage points at annual rates:									
Effect of R&D as investment[2]	0.10	0.06	0.03	0.06	0.06	0.15	0.23	0.16	0.10
Business	0.09	0.09	0.07	0.05	0.07	0.09	0.14	0.11	0.05
Government	0.01	–0.03	–0.04	0.00	–0.01	0.05	0.08	0.05	0.04
Nonprofit institutions serving households	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1987	1988	1989	1990	1991	1992	1993	1994	1995
Percent change at annual rate:									
Real GDP[1]	**3.35**	**4.18**	**3.62**	**1.95**	**–0.01**	**3.36**	**2.65**	**4.01**	**2.71**
Percentage points at annual rates:									
Effect of R&D as investment[2]	0.08	0.18	0.19	0.13	0.16	0.14	0.06	0.10	0.27
Business	0.02	0.10	0.12	0.07	0.13	0.08	0.02	0.05	0.20
Government	0.06	0.07	0.06	0.05	0.02	0.06	0.04	0.05	0.06
Nonprofit institutions serving households	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00
	1996	1997	1998	1999	2000	2001	2002	2003	2004
Percent change at annual rate:									
Real GDP[1]	**3.94**	**4.72**	**4.37**	**4.62**	**3.86**	**0.86**	**1.48**	**2.57**	**3.65**
Percentage points at annual rates:									
Effect of R&D as investment[2]	0.34	0.35	0.31	0.32	0.32	0.13	0.00	0.15	0.17
Business	0.25	0.25	0.23	0.26	0.26	0.08	–0.06	0.06	0.07
Government	0.09	0.09	0.08	0.06	0.05	0.04	0.06	0.08	0.09
Nonprofit institutions serving households	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01

1. GDP with R&D treated as investment and with the double-counting of R&D software investment removed.

2. Includes business investment, consumption of fixed capital charges for government and nonprofit institutions serving households, and a net return to government and these nonprofit institutions.

NOTE. Implemented using the aggregate output price index.

Chart 1. R&D Investment as a Percent of Adjusted GDP, 1959–2004



GDP Gross domestic product
R&D Research and development
Note: Adjusted GDP includes the treatment of R&D as investment and the removal of the double-count of R&D software investment.

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Table D. Contributions to and Shares of the Annual Growth Rate of Real GDP With R&D Treated as Investment—Table Ends

NAICS code		1959–2004	1959–73	1973–95	1995–2004
	Average percent change at annual rate:				
	Real GDP[1]	**3.42**	**4.34**	**2.87**	**3.34**
	Average percentage points at annual rates:[3]				
	GDP excluding R&D investment	3.25	4.10	2.77	3.11
	Effect of R&D as investment[2]	0.17	0.24	0.10	0.23
	Business	**0.09**	**0.07**	**0.07**	**0.16**
3254	Pharmaceutical and medicine manufacturing	n.a.	n.a.	n.a.	0.03
3251–53, 3255–56, 3259	Other chemical manufacturing	n.a.	n.a.	n.a.	0.01
3341	Computers and peripheral equipment manufacturing	n.a.	n.a.	n.a.	0.00
3342	Communication equipment manufacturing	n.a.	n.a.	n.a.	0.01
3344	Semiconductor and other electronic component manufacturing	n.a.	n.a.	n.a.	0.01
3345	Navigational, measuring, electromedical, and control instruments manufacturing	n.a.	n.a.	n.a.	0.01
3343, 3346	Other computer and electronic products	n.a.	n.a.	n.a.	0.00
3361–63	Motor vehicles, bodies and trailers, and parts manufacturing	n.a.	n.a.	n.a.	0.01
3364	Aerospace product and parts manufacturing	n.a.	n.a.	n.a.	0.00
3365–66, 3369	Other transportation equipment manufacturing	n.a.	n.a.	n.a.	0.00
5112	Software publishing	n.a.	n.a.	n.a.	0.02
5415	Computer systems design and related services	n.a.	n.a.	n.a.	0.01
5417	Scientific research and development services	n.a.	n.a.	n.a.	0.01
	All other for-profit industries	n.a.	n.a.	n.a.	0.03
	Government	**0.08**	**0.17**	**0.02**	**0.07**
	Nonprofit institutions serving households	0.00	0.00	0.00	0.01
	Percent of average annual growth:[4]				
	GDP excluding R&D investment	95.00	94.40	96.50	93.04
	Effect of R&D as investment[2]	5.00	5.60	3.50	6.96
	Business	**2.57**	**1.60**	**2.53**	**4.64**
3254	Pharmaceutical and medicine manufacturing	n.a.	n.a.	n.a.	1.01
3251–53, 3255–56, 3259	Other chemical manufacturing	n.a.	n.a.	n.a.	0.15
3341	Computers and peripheral equipment manufacturing	n.a.	n.a.	n.a.	0.07
3342	Communication equipment manufacturing	n.a.	n.a.	n.a.	0.33
3344	Semiconductor and other electronic component manufacturing	n.a.	n.a.	n.a.	0.36
3345	Navigational, measuring, electromedical, and control instruments manufacturing	n.a.	n.a.	n.a.	0.25
3343, 3346	Other computer and electronic products	n.a.	n.a.	n.a.	0.03
3361–63	Motor vehicles, bodies and trailers, and parts manufacturing	n.a.	n.a.	n.a.	0.27
3364	Aerospace product and parts manufacturing	n.a.	n.a.	n.a.	0.13
3365–66, 3369	Other transportation equipment manufacturing	n.a.	n.a.	n.a.	0.03
5112	Software publishing	n.a.	n.a.	n.a.	0.55
5415	Computer systems design and related services	n.a.	n.a.	n.a.	0.33
5417	Scientific research and development services	n.a.	n.a.	n.a.	0.25
	All other for profit industries	n.a.	n.a.	n.a.	0.88
	Government	**2.33**	**3.94**	**0.87**	**2.16**
	Nonprofit institutions serving households	**0.10**	**0.06**	**0.11**	**0.16**

n.a. Not available
NAICS North American Industry Classification System

1. GDP with R&D treated as investment and with the double-counting of R&D software investment removed.

2. Includes business investment, consumption of fixed capital charges for government and nonprofit institutions serving households, and a net return to government and these nonprofit institutions.

3. Average annual contributions to GDP growth including R&D are computed as the arithmetic average of annual contributions to growth.

4. Percent of total is computed as the ratio of average annual contributions to growth over the average growth of GDP including the effects of treating R&D as investment.

NOTE. Implemented using the aggregate output price index.

higher for all years before 1999. Beginning in 1999, current-dollar GDP was lower because of the increasing impact of the software adjustment.

Crosswalk of Changes in R&D Investment for Business and for Government, 2002[1]

[Billions of dollars]

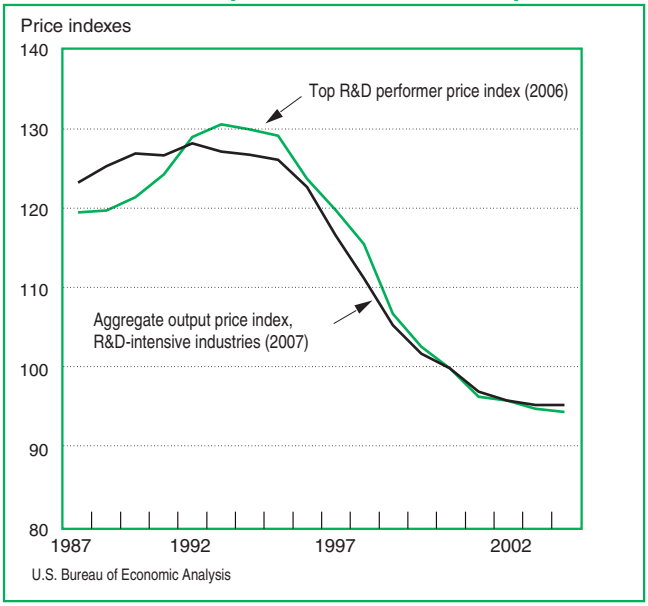
	2002
Business R&D investment (2006 vintage)	**170.8**
Plus: Import adjustment	–4.0
Plus: Adjustment to R&D purchases by business from a cost basis to an imputed purchase price	3.9
Plus: Purchases of nonscientific R&D	4.0
Plus: Reallocation of Federal to non-Federal split[2]	9.5
Plus: Other	2.7
Equals: Business R&D investment (2007 vintage)	**186.9**
Government R&D investment (2006 vintage)	**98.3**
Plus: Reallocation of Federal/non-Federal split[2]	–9.5
Plus: Adjustment to Federal purchases of R&D from business from a cost basis to an imputed purchase price	2.3
Plus: Other	–0.3
Equals Government R&D investment (2007 vintage)	**90.8**

1. The double-count is not included in this table, because it was taken out of software investment rather than R&D investment.
2. The reallocation of Federal and non-Federal R&D from a BEA estimate to an NSF survey-based split was made to provide better internal consistency for the industry estimates, the largest component of R&D performance and investment.

To illustrate the differences between the updated and previous estimates, the table above provides a crosswalk for 2002. The adjustments shown in the table were made to improve the accuracy of the measures of R&D investment and to expand the boundary of capitalized R&D to include international transactions and purchases of nonscientific R&D.

As shown in table C, the previous estimates of real GDP growth are similar to the updated estimates, but in the updated estimates, the average growth rate was slightly higher in 1959–73. In part, the difference in estimates was due to the use of an improved R&D output price index. Chart 2 shows the difference in the indexes in the earlier years.

Chart 2. R&D Output Price Indexes Comparison



R&D as Investment by Industry

New R&D estimates for 13 R&D-intensive industries

For the first time, the R&D account provides statistics on R&D investment for R&D-intensive industries for 1987–2004. Specifically, the account provides estimates of gross output and value added for these industries when R&D is treated as investment.

The R&D account provides detail for 13 R&D-intensive industries, which accounted for more than two-thirds of business R&D spending in 2004 and have the highest ratios of R&D investment to industry receipts. These industries include pharmaceutical and medicine manufacturing, computer and peripheral equipment manufacturing, semiconductor manufacturing, software publishing, computer systems design services, and six other industries.[5]

The R&D investment by industry estimates were based on the framework that was developed to treat spending on software as investment for the 1999 comprehensive benchmark revision of the NIPAs. The steps involved in adjusting gross output, intermediate inputs and value added for R&D as investment are shown in table 8 for the pharmaceutical and medicine manufacturing industry for 1987–2004.

Gross output is equal to the sum of an industry's sales, other operating income, commodity taxes, and inventory change. Treating R&D as investment would add the value of own-account R&D investment to industry gross output.

Intermediate inputs measure an industry's use of the secondary factors of production, energy, materials and purchased services; treating own-account R&D as investment does not change the industry purchases of intermediate inputs.

Value added measures the contribution of an industry or sector to GDP. It is measured as gross output less intermediate inputs. Own-account R&D investment thus adds to both gross output and value added.

Business purchases of R&D do not affect industry gross output, but they do change intermediate inputs because these purchases are reclassified as investment. The value of intermediate inputs falls by the value of the R&D investment, and value added increases by the same amount. Industry value added rises by the value of R&D investment less the R&D software double-count.

The estimates of R&D investment by industry were

5. Three manufacturing groups can be shown with these data—chemical manufacturing (NAICS 325), computer and electronic product manufacturing (NAICS 334), and transportation equipment manufacturing (NAICS 336). For a list of the detailed industries, see table E.

developed by mapping the NSF's data on industry R&D expenditures into the industry classification framework of BEA's industry accounts, which is based on establishments. An establishment-based approach provides the data for a richer understanding of industry behavior, in particular, of industry productivity. For more information, see the box "Accounting for R&D Performance" on page 64.

Industry results

Recognizing R&D as investment changes the relative importance of the 13 industries as contributors to economic growth. Table E compares each industry's share of private industry value added before and after the adjustment for R&D investment and its contribution to the growth rate of private industry value added.

In 1995–2004, if R&D were treated as investment, private industry value added would have grown an average 3.4 percent.[6] That compares with 3.2-percent growth according to the unadjusted estimate. The rows of table E show each industry's share of the growth.

Compared with unadjusted estimates, the contribution of pharmaceutical and medicine manufacturing to the growth in real private industry value added would be three times larger if R&D were treated as investment (1.8 percent, compared with 0.5 percent). In the scientific R&D services industry, the contribution would triple (1.3 percent, compared with 0.4 percent) mainly because BEA's GDP-by-industry classification structure is establishment-based rather than company-based and much R&D output is produced in dedicated R&D establishments. The contributions of the software publishing industry and the computer services industry would both increase if R&D were treated as investment. The slight reduction in the share of growth in private industry value added attributed to the computer and peripheral equipment manufacturing industry is due to the slower growth of real R&D investment relative to the industry's real output.

Another way to look at the impact of capitalizing R&D on specific industries is to identify the growth in GDP that stems from business R&D investment. If R&D were treated as investment, business R&D would account for 2.6 percent of the average annual growth in real GDP (table D) in 1959–2004; the contribution would be greater in recent years, 4.6 percent in 1995–2004. Chart 3 shows the impact on the information, communication, and technology producing sector and the biotechnology sector, which contains pharmaceutical and medicine manufacturing and scientific R&D

6. This growth rate differs from that of GDP because (1) the source data used for the estimates differ and (2) the scope of measurement here is only the value added of private industries, not the government and nonprofit sectors.

Table E. Private Industry Value Added Unadjusted and Adjusted for R&D as Investment, Growth Rate, Industry Share of Growth Rate, and Industry Share of Private Industry Value Added 1995–2004

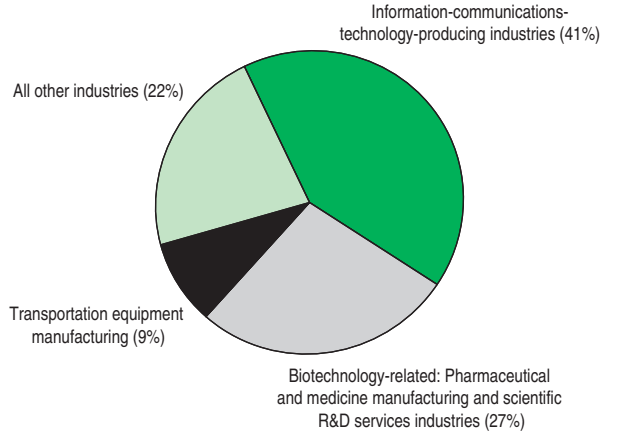
[Percent]

NAICS code		Growth rate in private industry value added		Average annual industry value added as a percent of average annual total private industry value added	
		Unadjusted [1]	Adjusted [2]		
	All industries	**3.24**	**3.35**		
		Industry share of growth rate in private industry value added [3]			
		Unadjusted [1]	Adjusted [2]	Unadjusted	Adjusted
3254	Pharmaceutical and medicine manufacturing	0.5	1.8	0.6	0.9
3251–53,3255–56,3259	Chemicals minus pharmaceutical and medicine manufacturing	1.2	1.3	1.4	1.5
3341	Computer and peripheral equipment manufacturing	5.5	5.3	0.2	0.3
3342	Communications equipment manufacturing	0.3	0.7	0.3	0.4
3344	Semiconductor and other electronic component manufacturing	8.5	8.5	0.7	0.8
3345	Navigational, measuring, electromedical, and control instruments manufacturing	–0.1	0.2	0.6	0.6
3343, 3346	Other computer and electronic products manufacturing	–0.1	–0.1	0.1	0.1
3361–63	Motor vehicles, bodies and trailers, and parts manufacturing	0.9	1.1	1.4	1.6
3364	Aerospace product and parts manufacturing	0.0	0.2	0.6	0.7
3365–66, 3369	Other transportation equipment manufacturing	0.1	0.1	0.2	0.2
5112	Software publishers	2.6	2.9	0.5	0.6
5415	Computer systems design and related services	3.4	3.5	1.3	1.3
5417	Scientific research and development services	0.4	1.3	0.5	0.6
	All other industries	76.6	73.2	91.6	90.4

NAICS North American Industry Classification System
R&D Research and development
1. Corresponds to published values.
2. Value added with R&D treated as investment and with the double-counting of R&D software removed.
3. Calculated as the average annual industry contribution to the percent change in adjusted and unadjusted chain-type quantity index of value added.
NOTE. Implemented using the aggregate output price index.

services. Together, these two sectors account for more than half of the average contribution to growth between 1995 and 2004.

Chart 3. Sources of Business R&D's Contribution to Real GDP Growth, 1995–2004



Does not sum to 100 because of rounding.

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Estimates of current-dollar and real investment for business are also provided for these industries for 1987–2004 (tables 5.1 and 5.2). Real investment is estimated using the same price index featured in the NIPA-based satellite account—the aggregate R&D output price index.

The estimates show the impact of treating R&D as investment on private industry gross output and value added. Current-dollar and real (inflation-adjusted) estimates using this price index are provided (tables 7.1A–7.3B).

The primary source for the R&D data used in the industry satellite account was the National Science Foundation's Survey of Industrial R&D, which provided industry detail on expenditures for the performance of R&D. These data were supplemented with BEA data on international services trade, Economic Census data on receipts for the R&D services industry, and unpublished data from BEA, the Census Bureau, and NSF that were used to allocate R&D performance and investment to industries.

R&D and BEA's Regional and International Accounts

Regional accounts

For the first time, the R&D account includes a regional component that provides estimates of the impact of treating R&D as investment on GDP by state for 1998–2002. These estimates are best seen as experimental, as there are several issues that BEA must work through in its attempt to provide the most accurate estimates. An overview is provided in this section.

Because regional statistics are calculated consistently with the GDP statistics, treatment of R&D as investment at the state level is consistent with the main definitions and conventions developed for the national accounts. However, one issue that is particularly challenging for the GDP-by-state accounts is the appropriate geographical allocation of R&D investment. Should R&D investment be allocated to the location where the R&D is performed? Or should the allocation of R&D investment cross state borders if it is used (and affects output) in multiple states? R&D that is funded and performed in a company's headquarters in one state can be shared with the company's operations throughout the country. Locating the R&D entirely in the state in which the R&D is performed and funded is conceptually problematic when the investment is shared with locations in other states.

Capitalizing R&D would require that purchased R&D be reclassified from an expense to investment, thus lowering intermediate expenditures and raising GDP by the same amount. To allocate this addition to GDP to the proper state, the location of industries that purchase the R&D output must be determined. The every 5-year Economic Census can be used to allocate national estimates of R&D output to states for Economic Census years. For other years, state shares of employment or wages from other establishment-based data, such as the Quarterly Census of Employment and Wages data from BLS, could be used to allocate the national estimates. However, there is no information on the location of the industries that purchase R&D output. Consequently, a choice of assumptions is required. One can either assume that R&D investment occurs in the state in which it is performed or assume that R&D investment is proportional to industry output. In the latter case, R&D investment would be allocated to states based on states' shares of R&D-using industries. BEA is studying the merits of each assumption. For these initial estimates, BEA assumed R&D investment was distributed across states in proportion to the state shares of industry-funded R&D according to NSF.

As for own-account R&D, it would be estimated and added to the total gross output of the industries performing own-account R&D. In general, NSF data on business-funded R&D would be used to allocate BEA's national estimates of industry-funded R&D to states, and the NSF data on government-funded R&D would be used to allocate BEA's national estimates of consumption of fixed capital and net returns for government funded R&D. To account for this correctly, the location of the industries performing own-account R&D must be determined. For the case of single-estab-

lishment firms, the R&D investment would be allocated to the state in which the R&D is performed. For a firm with establishments in multiple states, the location of investment could be determined by assigning the value of investment proportionately to the output of the firm's establishments.

In addition, the GDP-by-state accounts would logically use the same R&D price indexes used in the national and industry components of the satellite account when calculating real R&D investment. It would also use national depreciation rates to calculate the net stock of R&D assets.

Table F provides illustrative estimates of how the new treatment of R&D might affect GDP-by-state for 1998–2002.[7] This table shows the largest impacts are for New Mexico, Maryland, and Rhode Island. For New Mexico, GDP-by state would rise by an average 8.2 percent. For many states, however, the impact on GDP-by-state would likely be within 1.0 percentage point of the estimated U.S. impact of 2.8 percent. Impacts would exceed 1.0 percentage point above the U.S. impact for 10 states, and would be more than 1.0 percentage point below in 19 states.

7. These GDP-by-state impact estimates differ from those in table A because the GDP-by-state estimates incorporated parameters from the 2006 vintage R&D satellite account.

International accounts

For the first time, the R&D account includes an international component that shows the impact of treating R&D as investment on several dimensions of international transactions, including international transactions balances, the international investment position, and value added for MNCs for 1995–2004. Like the regional estimates, the international estimates are best seen as experimental, as there are important methodological issues that BEA is currently studying.

Capitalizing MNC R&D raises several practical and conceptual issues that can affect estimates of R&D capital stocks. Two issues are particularly notable. The first issue is conceptual. R&D—like some other intangible assets, but unlike conventional physical capital—can be shared without cost. A parent company that shares R&D results with an overseas affiliate neither increases the MNC-wide stock of R&D capital nor lowers its own stock of R&D capital. However, it does raise the R&D capital stock of its affiliate. The sharing of R&D capital among different parts of an MNC, which may be regarded as a form of joint ownership, becomes an economic accounting problem when the boundaries of MNCs do not stop at the boundaries of the countries for which estimates are made. Whether and how to measure such sharing is a problem without a clear resolution.

The second issue arises because of data limitations.

Table F. Illustrative Estimates of the Effect on the Level of GDP by State With R&D Treated As Investment

[Percent]

	1998	1999	2000	2001	2002	Average 1998–2002		1998	1999	2000	2001	2002	Average 1998–2002
United States	2.7	2.8	2.9	2.8	2.7	2.8	Missouri	1.3	1.3	1.6	1.6	1.4	1.5
Alabama	2.2	2.0	2.0	2.3	2.2	2.1	Montana	1.2	1.1	1.1	1.3	1.2	1.1
Alaska	1.8	1.1	1.0	1.4	1.2	1.3	Nebraska	0.7	0.9	5.1	1.2	1.2	1.8
Arizona	1.9	3.6	2.2	2.1	2.6	2.5	Nevada	1.0	0.8	0.6	0.6	0.7	0.7
Arkansas	0.6	0.7	0.8	0.8	0.7	0.7	New Hampshire	3.7	3.5	2.1	4.3	3.6	3.4
California	4.4	4.4	4.8	4.3	4.1	4.4	New Jersey	3.7	3.3	4.1	3.3	3.6	3.6
Colorado	3.7	3.1	2.9	2.8	2.5	3.0	New Mexico	8.1	8.3	7.8	5.9	10.8	8.2
Connecticut	2.6	3.1	3.3	3.4	4.3	3.3	New York	2.2	2.1	2.0	2.0	1.8	2.0
Delaware	6.9	3.4	3.9	3.1	3.0	4.1	North Carolina	2.0	2.1	2.1	2.2	1.9	2.1
District of Columbia	6.5	5.9	5.4	5.1	4.9	5.6	North Dakota	0.9	1.2	1.1	2.7	1.7	1.5
Florida	1.3	1.1	1.2	1.3	1.2	1.2	Ohio	2.2	2.5	2.3	2.6	2.3	2.4
Georgia	1.1	1.2	1.1	1.2	1.4	1.2	Oklahoma	0.8	0.9	0.9	1.0	0.9	0.9
Hawaii	0.8	0.9	1.0	1.1	1.2	1.0	Oregon	2.0	2.0	2.1	5.2	2.6	2.8
Idaho	4.1	4.5	4.6	2.9	4.0	4.0	Pennsylvania	2.6	3.0	2.8	3.0	2.5	2.8
Illinois	2.2	2.3	3.0	2.4	2.3	2.5	Rhode Island	6.3	6.2	5.3	5.4	5.2	5.7
Indiana	1.9	1.7	1.8	2.3	2.2	2.0	South Carolina	1.1	1.1	1.2	1.3	1.5	1.2
Iowa	1.5	1.3	1.4	1.6	1.5	1.5	South Dakota	0.4	0.4	0.5	0.7	0.5	0.5
Kansas	2.2	2.3	2.0	2.2	2.4	2.2	Tennessee	1.7	1.6	1.4	1.7	1.5	1.6
Kentucky	0.7	0.9	0.9	0.9	1.0	0.9	Texas	1.8	2.0	1.8	1.8	1.9	1.9
Louisiana	0.6	0.6	0.6	0.7	0.7	0.7	Utah	2.8	2.7	2.4	2.4	2.4	2.5
Maine	0.6	0.8	1.1	1.2	1.2	1.0	Vermont	1.3	2.6	3.0	2.4	2.2	2.3
Maryland	6.4	6.1	6.3	7.2	5.1	6.2	Virginia	2.7	2.6	2.4	2.4	2.4	2.5
Massachusetts	6.4	5.5	5.5	5.9	5.5	5.8	Washington	4.7	4.4	5.4	5.0	4.8	4.9
Michigan	4.7	5.8	5.9	4.9	4.5	5.2	West Virginia	1.3	1.3	1.4	1.3	1.3	1.3
Minnesota	2.5	2.4	2.5	2.8	2.8	2.6	Wisconsin	1.7	1.6	1.7	2.0	2.0	1.8
Mississippi	0.8	1.0	1.1	1.2	1.2	1.0	Wyoming	0.6	0.5	0.5	0.5	0.5	0.5

NOTE. Calculated as the ratio of the adjustment to unadjusted GDP by state.

In contrast to the domestic stock of R&D capital, the stock of MNC R&D capital can increase not only through R&D investment, but also through the entry into the MNC population of firms that hold preexisting R&D stocks. The result is that computing changes in MNC capital stocks becomes more complicated than simply summing up investment and subtracting depreciation. Conceptually an obvious solution would be to simply estimate the R&D stocks of entering firms and acquisitions by existing firms. However, existing data allow for only very rough estimates of "entry effects."[8]

Table G provides illustrative estimates of the impact of R&D as investment on several components of the international accounts. The international transactions accounts, which summarize economic transactions between the United States and the rest of the world, consist of the current account, the capital account, and the financial account. The first two balances shown, on direct investment income and international investment income, are components of the current account balance, which reflects the combined balances on trade in goods and services (exports less imports), income (receipts less payments), and unilateral current transfers (transfers received less transfers made). The net international investment position is the cumulative end-of-year value of U.S.-owned assets abroad (outward investment) less foreign-owned assets in the United States (inward investment).

In the international transactions accounts in 2004, the current-account deficit would fall $1.3 billion, or 0.2 percent. The $1.3 billion change would result in bigger changes for other measures: The surplus on direct investment income would rise 0.9 percent, and the surplus on total international investment income would rise 2.3 percent.

In the international investment position accounts, treating R&D as investment would raise the outward direct investment position $125.0 billion, or 5.1 percent, in 2004. The inward direct investment position would rise $149.2 billion, or 8.6 percent. The net (outward minus inward) direct investment position would fall $24.2 billion, or 3.2 percent. The $24.2 billion change would result in a marginal rise in the net international investment position, which includes both di-

8. In practice, estimates of "entry effects" must net the R&D capital stocks held by exiting firms against stocks held by entering firms.

Table G. Illustrative Estimates of the Effect on Selected International Accounts Measures Unadjusted and Adjusted for R&D as Investment

[Billions of dollars]

	International transactions balances [1]					
	Direct investment income [2]		International investment income [2]		Current account [3]	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1995	64.9	60.6	20.9	16.6	–113.6	–117.9
1996	69.4	65.7	22.3	18.6	–124.8	–128.5
1997	72.4	68.3	12.6	8.6	–140.7	–144.8
1998	65.5	57.3	4.3	–4.0	–215.1	–223.3
1999	78.2	71.9	13.9	7.6	–301.6	–307.9
2000	94.9	89.9	21.1	16.0	–417.4	–422.5
2001	115.9	111.3	31.7	27.1	–384.7	–389.3
2002	102.3	99.2	27.7	24.5	–459.6	–462.8
2003	112.7	109.1	45.4	41.8	–522.1	–525.7
2004	139.4	140.7	56.4	57.7	–640.1	–638.8
	International investment position					
	Outward investment		Inward investment		Net position [4]	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1995	3,486.3	3,553.7	3,944.7	4,011.0	–458.5	–457.3
1996	4,032.3	4,104.0	4,527.4	4,600.0	–495.1	–496.0
1997	4,567.9	4,642.9	5,388.6	5,467.7	–820.7	–824.8
1998	5,095.5	5,175.0	5,990.9	6,082.4	–895.4	–907.4
1999	5,974.4	6,061.1	6,740.6	6,843.5	–766.2	–782.4
2000	6,238.8	6,331.1	7,620.0	7,735.6	–1,381.2	–1,404.4
2001	6,308.7	6,406.2	8,228.1	8,353.1	–1,919.4	–1,946.8
2002	6,652.2	6,755.4	8,740.3	8,871.8	–2,088.0	–2,116.4
2003	7,643.5	7,755.3	9,783.9	9,924.6	–2,140.4	–2,169.4
2004	9,257.1	9,382.1	11,551.5	11,700.7	–2,294.4	–2,318.6
	Value added of multinational companies [5]					
	Majority-owned foreign affiliates		U.S. parents		Majority-owned U.S. affiliates	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1995	465.6	476.5	1,365.5	1,453.6	254.9	269.8
1996	498.3	510.2	1,480.6	1,572.8	283.4	299.1
1997	520.9	533.1	1,573.5	1,672.9	313.7	330.3
1998	506.3	518.3	1,594.5	1,702.2	353.9	375.3
1999	566.4	581.0	1,914.3	2,035.7	397.3	420.2
2000	606.6	623.7	2,141.5	2,272.0	447.3	472.2
2001	585.7	602.6	1,892.4	2,030.5	417.1	442.1
2002	601.6	620.3	1,858.8	1,991.4	460.6	486.5
2003	697.8	718.2	1,958.1	2,093.9	475.1	503.1
2004	824.3	850.2	2,215.8	2,364.0	511.5	539.6

R&D Research and development

1. The international transactions accounts summarize economic transactions between the United States and the rest of the world; they consist of the current account, the capital account, and the financial account.

2. These balances are components of the current-account balance.

3. This balance reflects the combined balances on trade in goods and services (exports less imports), income (receipts less payments), and unilateral current transfers (transfers received less transfers made).

4. The net position is the cumulative end-of-year value of outward investment (of U.S.-owned assets abroad) less inward investment (of foreign-owned assets in the United States).

5. Value added is the portion of a firm's output that reflects the firm's production. In these estimates, it is measured as the sum of costs incurred (excluding intermediate inputs) and profits earned in production.

rect and other types of investment.

These illustrative aggregate-level estimates suggest that the effects of capitalizing R&D data on total capital stocks and value added of MNCs would not be inconsequential. Value added is the portion of a firm's output that reflects the production of the firm itself. In these estimates, it is measured as the sum of costs incurred (except for intermediate inputs) and profits earned in production.

In the MNC operations data, the value added of majority-owned foreign affiliates of U.S. MNCs would rise $25.9 billion, or 3.1 percent, with R&D capitalization. The value added of majority-owned U.S. affiliates of foreign MNCs would rise $28.l billion, or 5.5 percent. For U.S. parent companies, value added would rise $148.2 billion, or 6.7 percent.

Acknowledgments

Dennis Fixler, Chief Statistician, and Sumiye Okubo, Associate Director for Industry Accounts, directed the R&D satellite account project. Carol E. Moylan, Chief of the National Income and Wealth Division, supervised the preparation of NIPA-based estimates. John W. Drewry and Andrew G. Schmidt prepared the NIPA-based estimates. Carol A. Robbins supervised the preparation of the industry estimates. Gabriel W. Medeiros prepared the industry-based estimates. G. Andrew Bernat prepared the regional estimates, and Daniel R. Yorgason prepared the international estimates.

Maria Borga, Felicia V. Candela, Jeffrey W. Crawford, Mahnaz Fahim-Nader, Leonard J. Loebach, Lisa S. Mataloni, Justin M. Monaldo, Laura I. Schultz, Brian K. Sliker, and Erich H. Strassner prepared data analysis and other review materials. David B. Wasshausen and Steven L. Zemanek provided technical assistance.

J. Steven Landefeld, Rosemary D. Marcuss, Brent R. Moulton, Joel D. Platt, Obie G. Whichard, Benjamin R. Bridgman, Adam M. Copeland, Bruce T. Grimm, Ned G. Howenstine, Charles Ian Mead, George M. Smith, and William J. Zeile provided valuable comments throughout the project.

John E. Jankowski, Director, R&D Statistics Program, and Francisco A. Moris of the National Science Foundation contributed guidance and support throughout the project, and prepared supplementary data and analysis. R&D data and discussion and consultation were provided by the members of the Division of Science Resources Statistics (SRS) staff at the National Science Foundation (NSF). Supplementary data were provided by Richard S. Hough of the U.S. Census Bureau. Funding for this project was provided by NSF/SRS.

How R&D Investment Affects GDP and GDI

Treating research and development (R&D) as an investment rather than as an expense in the calculation of gross domestic product (GDP) and gross domestic income (GDI) would result in important changes to both measures (see table below).

Business sector

Currently, business spending on R&D is not included in the calculation of GDP, which is a measure of final demand. Rather, R&D expenditures are considered business expenses, that is, purchases of intermediate inputs that are used in the production process. Shifting business R&D expenditures out of expenses and into investment would lead to an increase in GDP equal to the value of R&D investment.

Recognizing R&D as investment would also affect GDI via two components: Business income and depreciation (consumption of fixed capital).

Because R&D would no longer be considered an expense, it would no longer be deducted from gross business income (corporate profits and proprietors' income). So business income would increase.

Depreciation would also increase because R&D investment adds to the capital stock, which is subject to a decline in value over time. The net effect on business income would be that it increases by the amount of R&D investment less depreciation.

However, because depreciation of the capital stock is also a component of GDI, the depreciation of R&D investment would be added to the total measure of depreciation. So the net effect on GDI would be an increase equal to R&D investment, maintaining the accounting identity between GDP and GDI.

Nonprofits and general government

In these two sectors, R&D expenditures would be reclassified from consumption to investment. Because consumption is already part of GDP, this shift alone would not change the measure of GDP.

However, recognizing R&D spending as investment by nonprofit institutions serving households (household sector) and governments would also require an estimate of the capital services generated by R&D investment. Capital services measure the value of a capital asset's use in production. Conceptually, that value is the amount a producer would be willing to pay to rent the asset for a given period. Because most capital assets are owned by the same entity that uses them, capital services must be estimated indirectly.

In the R&D satellite account, capital services are defined as the sum of depreciation and the net returns on R&D investment. The inclusion in the R&D account of net returns to nonprofits and general government is a departure from BEA's current calculation of GDI, which includes only depreciation, a partial measure of capital services. The BEA R&D account, however, allows for exploratory approaches, and returns on R&D investment seem to have been significant. Also, accounting for net returns is roughly parallel with the treatment in the business sector. In that sector, net returns are assumed to be included in business income.

For nonprofits and government, output is generally not sold at market prices, so the value of output must be measured indirectly, based on the costs or expenses incurred in production. For nonprofits, PCE for services would rise by an amount equal to capital services. Government consumption would rise by the same amount.

Treating R&D as Investment: Effect on GDP and GDI

	Gross domestic product (GDP)			Gross domestic income (GDI)	
Sector	Current treatment in GDP	Adjusted GDP [1]	Change to GDP	Adjusted GDI [2]	Change to GDI
Business	Expenses	R&D spending reclassified to investment	Increase equals the value of R&D investment	1. Increase in business income equal to R&D investment less CFC 2. Increase in CFC	Increases by value of R&D investment
Nonprofit institutions serving households (part of the household sector)	PCE	1. R&D spending reclassified to investment 2. PCE for services boosted	1. No change from reclassification 2. PCE services increase equal to capital services (CFC plus net returns)	1. Returns to R&D capital added [3] 2. CFC boosted	Increases by value of capital services (net returns plus depreciation)
General government	Government consumption	1. R&D spending reclassified to investment 2. Government spending on services boosted	1. No change from reclassification 2. Government spending on services increase equal to capital services (CFC plus net returns)	1. Returns to R&D capital added [3] 2. CFC boosted	Increases by value of capital services (net returns plus depreciation)

1. Adjusted GDP incorporates the impact of treating R&D as investment.
2. Adjusted GDI incorporates the impact of treating R&D as investment.
3. Currently, GDI does not include a measure of returns on government or nonprofit investment.

CFC Consumption of fixed capital
PCE Personal consumption expenditures

Sumiye Okubo

The Broader World of Innovation

Why an R&D satellite account?

The Bureau of Economic Analysis-National Science Foundation research and development (R&D) satellite account uses the national income and product accounts (NIPA) framework to explore channels through which R&D affects economic growth and to estimate the size of those effects. Such analysis is applicable to the broader world of innovative activity, or in other words, investment in intangible assets. R&D spending was chosen as the subject of the satellite account because (1) experts broadly agree on its definition and (2) authoritative time-series data exist from long-established R&D survey data published by the NSF.[1]

The mandate of national economic accounting agencies around the world, including BEA, is to encompass in national accounts all economic activity within a country and to identify the economic interactions among businesses, governments, and households. Measuring investment in intangible assets is challenging. For example, many intangible assets are developed in-house and not bought and sold in markets. And many intangible assets have a "public good" aspect in that (1) some use of the asset can be made by the public without reducing the amount available and (2) some benefits from the use of the asset accrue to entities other than the owner.

On the other hand, intangible capital—or "knowledge" capital—shares key characteristics with tangible capital. Intangible capital is used in production for more than 1 year and generates returns to its owner.

Some intangible investment is included in the GDP at present. For example, expenditures on software have been treated as investment since 1999. The R&D satellite account introduces a new means of including R&D as investment in GDP and provides a framework for eventually adding other innovative activity.

How much innovation is out there?

There is no consensus on the total value of innovative activity in the economy. Research on the subject has intensified in recent years.[2]

One study, by Carol A. Corrado, Charles R. Hulten, and Daniel E. Sichel,[3] found that business investment in intangible assets roughly equals investment in tangible assets and has been growing faster than investment in tangibles in recent years.

The authors take a broad view of intangibles, one that encompasses computerized information (software and databases), innovative property (scientific and nonscientific R&D), and economic competencies (brand equity, such as certain advertising, and firm-specific resources, such as worker training and some management time). They found that scientific R&D, which is what the R&D account mostly measures, accounts for roughly one-fifth of total investment in intangible assets.

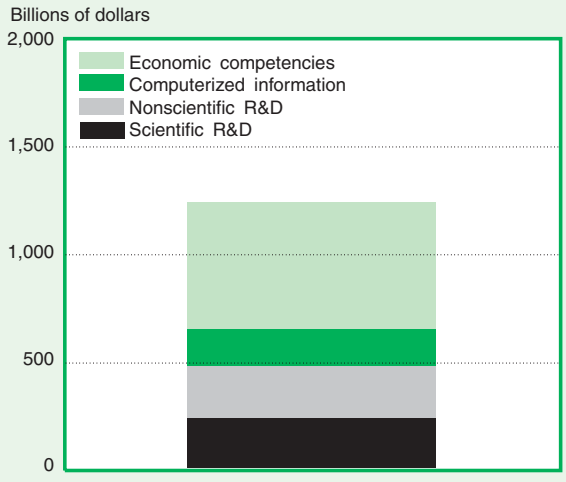
The development of a consensus on what comprises investment in intangible assets and the provision of broadly accepted measures of those investment expenditures will provide the groundwork for the addition of more intangible investment in the NIPAs.

1. For example, "*National Patterns of R&D Resources: 2004 Data Update*, NSF 06–327 (2006) and *Research and Development in Industry: 2003*, NSF 07–314 (2007).

2. For more information, see Leonard Nakamura, "Intangibles: What Put the 'New' in the New Economy?" Business Review (Federal Reserve Bank of Philadelphia, July/August 1999): 3–16; Susanto Basu, John G. Fernald, Nicholas Oulton, and Sylaja Srinivasan. "The Case of the Missing Productivity Growth, or Does Information Technology Explain Why Productivity Accelerated in the United States But Not in the United Kingdom?" in *NBER Macroeconomics Annual 2003*, eds. Mark Gertler and Kenneth Rogoff (Cambridge, MA: MIT Press, 2004): 9–63; and Stephen D. Oliner, Daniel E. Sichel, and Kevin J. Stiroh, "Explaining a Productive Decade," in *Brookings Papers on Economic Activity* 1 (Washington, DC: The Brookings Institution Press, 2007): 81–137.

3. Carol A. Corrado, Charles R. Hulten, and Daniel E. Sichel, "Intangible Capital and Economic Growth" (Finance and Economics Discussion Series, Federal Reserve Board, April 2006).

Broad View of Business Intangible Investment, 2000–2003 Average



Source: Corrado, Hulten, and Sichel (2006)

Rosemary D. Marcuss

Accounting for R&D Performance

Statistical agencies are often confronted with the task of assigning the various economic activities of a particular company to the most appropriate industry—or industries. In some cases, agencies find it appropriate to assign all the activity of a specific company to a single industry. In other cases, agencies find it more appropriate to assign the activity of individual establishments within the company to different industries.

Establishment-based approach

For the research and development (R&D) satellite account, the Bureau of Economic Analysis (BEA) has taken an establishment-based approach. This approach is consistent with BEA's GDP-by-industry accounts, which are frequently used for industry productivity analysis.

According to the establishment-based approach, the R&D activity performed at different establishments within a company are assigned separately. For example, a pharmaceutical company might perform R&D in a unit whose main activity (its primary industry) is manufacturing and in another unit whose main activity is R&D services. The R&D activity from each unit would be allocated to the manufacturing industry and the services industry.

In contrast, the National Science Foundation (NSF), which provides most of the source data for the R&D account, assigns all of a company's R&D activity to one industry, the company's primary industry. For a given company, this activity might include R&D activity performed in an R&D department in a manufacturing plant, at the company headquarters, and in separate R&D labs and subsidiaries.

The NSF's Survey of Industrial R&D (SIRD) does not link R&D expenditures to establishment types. Therefore, BEA adjusts the NSF data to assign R&D activity across all of company's establishments to appropriate industries.

BEA's adjustment process can be illustrated by the pharmaceutical and medicine manufacturing industry. For 2004, SIRD data show that companies classified in pharmaceutical and medicine manufacturing reported $31.5 billion of domestically performed R&D. A substantial portion of this $31.5 billion was actually performed in R&D labs and in company headquarters, not in manufacturing units. According to an establishment-based approach, only the R&D performed in the manufacturing units would be counted as part of pharmaceutical and medicine manufacturing industry R&D.

Unpublished data from the Census Bureau were used to approximate the portion of each company's R&D expenditures performed in R&D labs and company headquarters. For 2004, these expenditures were estimated to be about $18 billion—$17 billion performed in R&D labs, and $1 billion performed in company headquarters. This leaves about $13.5 billion, attributed to pharmaceutical and medicine manufacturing establishments (the primary industry).

To adjust the SIRD data for the industry estimates in the R&D account, the R&D output associated with the $18 billion spent in labs and at headquarters was reassigned from pharmaceutical and medicine manufacturing to scientific R&D services and to management of enterprises. While some of the remaining $13.5 billion may have been performed in other types of establishments that make up the companies in the pharmaceutical and medicine manufacturing industry, BEA did not have a means to separately identify these expenditures. Part of the remaining $13.5 billion represents the costs for R&D funded by or sold to others, leaving about $10.9 billion of R&D expenditures for the industry's use as "own-account" R&D investment.

From R&D performance to investment

The R&D account features industry R&D investment, not performance. After making several adjustments to the NSF performance data (table 8), BEA derived a total measure of R&D investment for the pharmaceutical and medicine manufacturing industry in 2004, $40.6 billion dollars.

This includes the $10.9 billion in own-account R&D investment performed in pharmaceutical and medicine manufacturing establishments and $29.7 billion in purchased and transferred R&D investment. This $29.7 billion includes all of the $18 billion performed in R&D labs and in headquarters plus an estimate of R&D purchased from other for-profit companies, other domestic nonbusiness performers, and foreign performers.

Carol A. Robbins

Tables 1.1 through 8 follow.