Methodology for the Industry Estimates in the 2007 R&D Satellite Account

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Abstract

This paper is part of a series that provides the details behind the Bureau of Economic Analysis's (BEA) satellite account on research and development (R&D) activity. It describes the data and experimental methodology used to create the GDP-by-Industry component of the satellite account for thirteen R&D-intensive industries and an aggregation of all other for-profit industries.

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The 2007 R&D satellite account provides experimental estimates of the impacts of treating R&D as investment in BEA's industry accounts. This industry component of the satellite account presents impacts on gross output, intermediate inputs and value added in a GDP-by-industry framework. It is a first step toward incorporating R&D as investment in the Benchmark Input-Output accounts.[1]

This paper is one of a set of background papers detailing the concepts and methodology used for the industry component of the satellite account estimates that are presented in the October 2007 issue of the *Survey of Current Business*.[2] It provides a preliminary framework showing that it is feasible to develop detailed industry estimates of R&D investment and the associated impacts on gross output, intermediate inputs, and value added that flow from changing the accounting treatment of R&D in the national economic accounts.

This methodology paper is organized as follows. First, an explanation is provided of how the capitalization of R&D will change BEA's GDP-by-industry accounts. Next, the steps involved in the transformation of the National Science Foundation expenditure data into consistent time series of industry investment are described, followed by the translation of these industry expenditures into measures of R&D investment and industry gross output and value added. Finally, the limitations of this experimental methodology are summarized. Appendix tables show the intermediate steps of the transformation of the data from reported expenditures into estimated investment.

[1] See Okubo (2007) for a detailed treatment of an Input-Output framework for R&D.
[2] Robbins and Moylan (2007).

1. Conceptual framework for the Estimates

The GDP-by-industry component of the R&D satellite account shows the impact of treating R&D as investment on R&D-intensive private industries. The concepts used in these estimates are based on the framework developed for the recognition of software as investment in the 1999 comprehensive revision of the National Income and Product Accounts (NIPAs).[3] Business purchases of R&D are treated as investment instead of the current treatment as intermediate inputs for the purchasing industry; own-account R&D production is redefined as part of industry gross output.[4]

These impacts are estimated on an industry basis by identifying the change in gross output and intermediate inputs brought about by the treatment of R&D as investment. For each industry, value added (VA), is calculated as gross output (GO) less intermediate inputs (II). The change in private industry *(i)*'s value added due to this new treatment is equal to private business investment in R&D (PBR&D):

$$VA_{(i)after} - VA_{(i)before} = PBR\&D_{(i)}$$

Private business investment for each industry is calculated as the sum of the production costs of own-account R&D plus expenditures for business purchases of R&D.

$$PBR\&D = \sum_{i=1to14} (Cost_{ownaccount(i)} + Expenditures_{purchasedR\&D(i)})$$

[3] Moulton, Parker, and Seskin (1999)

[4] The estimates described here are limited to the impact on private industry. For government and non-profit sectors, R&D is currently treated as a consumption expenditure measured as the sum of the costs of production. The gross output, or measures of the total value produced, for these sectors will increase by the amount of the income flows generated by this government and non-profit R&D stock when R&D is recognized as investment.

Own-account R&D investment is R&D output that businesses develop for their own use and expenditures for purchased R&D refers to R&D that businesses purchase from others instead of developing internally. The index *(i)* corresponds to the fourteen industry groups that are detailed in the 2007 industry component of the R&D satellite account. The cost of own-account R&D *(C(i))* includes current expenditures for R&D and the user cost of the fixed capital used in the production of R&D. In keeping with the practice of the NIPAs for own-account investment, this user cost is estimated as consumption of fixed capital (CFC) used in the production of the R&D.[5] Specifically, this is the CFC on the structures, equipment, and software used in the R&D production process. Thus the cost of own-account R&D is:

$$Cost_{own-account\,R\&D(i)} = C_{(i)} + CFC_{(i)}$$

Gross output measures total production; this includes both the value of what is produced and used by others in further production, and what is produced and sold to final users. It consists of sales (or receipts), other operating income plus taxes on commodities and changes in inventories, and the cost of own-account investment. Because some own-account R&D expenditures are used to create own-account software, there is an overlap with currently capitalized own-account software expenditures; this overlap (Cost (own-account SW R&D)) is subtracted to prevent double-counting:

$$GO_{R\&D\ adjusted} = GO + Cost_{own\ \ account\ R\&D} - Cost_{own-account\ \ SW\ R\&D}$$

[5] The net return, which reflects the opportunity cost of the fixed capital that could have been rented out or used for another purpose, is difficult to estimate in practice. Own-account R&D investment is thus measured in the satellite account without an explicit net return above CFC, while purchases of R&D, estimated as receipts, are assumed to include a return to the seller.

Intermediate inputs measure the goods and services that are used in the production process of other goods and services instead of sold in final-demand markets. Because business purchases of R&D are redefined from intermediate inputs to final demand, industry intermediate inputs fall by the amount of the industry's purchases of R&D.

$$II_{R\&D\ adjusted} = II_{unadjusted} - Exp_{purchasedR\&D}$$

Table 1 summarizes these adjustments for the pharmaceutical and medicine manufacturing industry for 2004. Own-account R&D adds $10.9 billion to industry gross output, and the own-account software R&D overlap subtracts $0.1 billion. With these adjustments, gross output with R&D treated as investment is $166.2 billion. Purchased R&D subtracts $29.7 billion from intermediate inputs. These changes to gross output and intermediate inputs increase value added by $40.5 billion, which equals the total of R&D investment less the own-account software R&D overlap.

2. Transformation of the R&D Expenditure Data into R&D investment

2.1 The scope of capitalized R&D

Two definitions parameterize the scope of R&D activity that should be considered investment in the industry accounts: The Frascati definition of R&D and the national accounting definition of an asset.

As described by the Frascati Manual, the internationally recognized guidelines on measurement of R&D expenditures, research and experimental development is

"…creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture, and society, and the use of this stock of knowledge to devise new applications (OECD (2002) par. 63)." This definition makes it clear that in addition to R&D in the natural sciences, it also covers R&D in the social sciences and the humanities. The quality that distinguishes Frascati-based R&D from related activity is "an appreciable element of novelty and the resolution of scientific and/or technical uncertainty (OECD (2002) par. 84)."

The second definition that shapes the scope of R&D that should be considered investment is the definition of an asset in national economic accounting. Assets in the national accounts have two key characteristics: 1) they provide their owner with economic benefits by holding or using them over a period of time, and 2) there are enforced ownership rights over these entities (CEC et al. 1993). For the industry component of the R&D satellite account, all industry-funded R&D activity is assumed to be an asset for the business sector.

2.2 Detailed Industries

The detailed industries presented were selected based on R&D intensity, evaluated in terms of R&D performance and R&D investment. They account for approximately two-thirds of business performed R&D between 1997 and 2004, based on NSF's published industry classification. Over the longer period of the industry estimates, 1987-2004, the detailed industries make up on average 64 percent of total R&D investment.

Detail Level for current dollar investment, gross output, and value added (North American Industry Classification System (NAICS) code)
Pharmaceutical and medicine manufacturing (3254)
Chemicals minus pharmaceutical and medicine manufacturing (325 except 3254)
Computer and peripheral equipment manufacturing (3341)
Communications equipment manufacturing (3342)
Semiconductor and other electronic component manufacturing (3344)
Navigational, measuring, electro-medical, and control instruments manufacturing (3345)
Other computer and electronic products manufacturing (3343, 3346)
Motor vehicles, bodies and trailers, and parts manufacturing (3361-3363)
Aerospace product and parts manufacturing (3364)
Other transportation equipment manufacturing (3365, 3366, 3369)
Software publishers (5112)
Computer systems design and related services (5415)
Scientific R&D Services (5417)
All other for-profit industries

The 4-digit industries presented, when aggregated to the 3-digit NAICS level, form three complete industries; these are chemical manufacturing (NAICS 325), electronic products manufacturing (NAICS 334), and transportation equipment manufacturing (NAICS 336).

2.3 NSF Expenditure Data

The primary source of R&D-related data for the industry estimates of R&D investment are drawn from the NSF's Survey of Industrial R&D (SIRD), the most comprehensive data available on R&D activity for domestic business in the U.S. The SIRD provides estimates of R&D expenditures for all domestically performed R&D in companies with five or more employees. The scope of included activity is science and engineering R&D, which excludes R&D activity in the social sciences and humanities.

The SIRD provides industry detail on expenditures for R&D performance and R&D funding from 1953 to the present, and these data are used in the satellite account to

estimate the cost of own-account R&D and the purchases of R&D by domestic industry. Current costs include wages, fringe benefits, materials and supplies, and all other R&D expenses (excluding capital expenditures). NSF also reports depreciation on the property and equipment used in the production of R&D; this depreciation charge is referred to hereafter as a capital consumption allowance (CCA).

These costs from the SIRD are summed to estimate own-account R&D investment for the R&D satellite account. The CCA or reported depreciation on R&D property and equipment is adjusted to convert it to the economic concept of depreciation used in the national accounts, CFC, by adding a capital consumption adjustment factor, hereafter referred to as *ccadj*.

Other aspects of the SIRD data that are exploited to produce these experimental industry estimates include R&D expenditures that are for software sold commercially, and expenditures for R&D performed by other types of performers (academic institutions and non-profit institutions), as well as industry funds for R&D performed by other domestic companies.

The SIRD is a company-based survey; all company expenditures for R&D performance are currently classified into the same industry regardless of how many different types of products the industry may produce or sell. For companies with more than one establishment, expenditure data are summed to the company level and assigned a single North American Industry Classification System (NAICS) code based on payroll.[6] SIRD data on total industry-performed R&D is divided in two funding components, the industry-performed R&D that is funded by the company or by other non-Federal entities,

[6] Research and Development in Industry: 1999, NSF 02-312, Project Officer, Raymond M. Wolfe, Arlington VA 2002, Methodology Section, page 123.

and the industry-performed R&D that is funded by the Federal government. These two components are used heavily in the estimation process of the industry satellite account.

2.4 Industry Classification adjustments to the SIRD Data

Three adjustments to the industry classification of the NSF data are necessary to prepare the data for use in the industry accounts. The first adjustment, referred to here as the backcasting adjustment, converts NSF's data for years prior to 1997 from the Standard Industrial Classification (SIC) to the North American Industrial Classification (NAICS). The second adjustment, referred to here as the wholesale trade adjustment, adjusts earlier years of data to account for a 2004 time series break in the NSF's industry classification system that corrected an overestimation of R&D expenditures for the wholesale trade industry. The third adjustment is a partial company to establishment adjustment that is applied to all years of the time series. It reassigns some R&D expenditures to different industries in order to align the R&D expenditures more closely to the establishments where the R&D was produced. Each adjustment is described below in greater detail. Appendix tables 1.1 through 1.3 and 2.1 through 2.3 show the intermediate steps of the data transformation for total industry R&D expenditures, company and other funds for industrial R&D, and Federal funds for industrial R&D.

2.5 The Backcasting Adjustment

R&D expenditures classified by SIC-based industry for the years 1987 to 1996 were converted to NAICS with the backcasting methods that have been developed at BEA to produce NAICS-based GDP-by-industry estimates from historical data that had

originally been created on an SIC basis.[7] For that original purpose, annual conversion matrices were created for sixty private nonfarm SIC-based industries using data from the 1997 benchmark I-O accounts, a year for which detailed data were available on both an SIC and NAICS basis. Detailed SIC-based information on shipments, sales, and receipts were used to develop the annual conversion matrices back to 1987, enabling them to capture changes in the NAICS composition of SIC industries over time.

To adapt this method to the SIRD expenditure data, conversion matrices created for gross output were used. When this method is used to convert the SIRD data, the underlying assumption is that for each cell of the SIC to NAICS conversion matrix, R&D expenditures are proportional to gross output. The SIRD data are converted from SIC to NAICS at the level of sixty industries; this required disaggregating several NSF industry groups. The thirteen detail industries plus the "all-other" aggregation are then selected from the sixty industries. Each industry's total expenditures and their company and other funds for R&D were backcast separately using the conversion matrix. In order to maintain the additivity of the converted data, the time series of Federal funds for R&D by industry was calculated as the residual between backcast total R&D and backcast company and other funds for R&D, rather than separately backcasting all three components. This resulted in an 18-year time series for fourteen industries covering the years 1987-2004.

Appendix tables 1.1 through 1.3 show the complete time series for the detailed industries plus the "all other" group. Data for years 1987-1996 are backcast, and data for years 1997-2004 are shown as reported by NSF.

[7] For more explanation, see Yuskavage and Pho (2004).

2.6 The Wholesale Trade Adjustment

The NAICS framework identifies industrial classification of establishments based on similarity of production process; identifying this primary activity can be done in more that one way. Prior to 2004, the industry classification system used in the SIRD survey assigned each company to an industry based on the activity that accounted for the highest percentage of its payroll across its establishments.[8] According to NSF in a 2006 InfoBrief, this existing methodology over time increasingly assigned the R&D performance of pharmaceutical or computer manufacturing firms to the wholesale trade industry because of the relative growth in the payrolls that was related to selling and distribution activities.[9]

The data NSF released for R&D expenditures for 2004 include a revised classification structure that reassigns this wholesale trade-classified R&D to the manufacturing industries that better matches the R&D activity and better reflects the source of industry receipts.[10] The industry reclassification of expenditures for 2004 resulted in a shift of $37.8 billion dollars of R&D expenditures from non-manufacturing industries (primarily wholesale trade) into the manufacturing sector. The reclassification doubled estimated R&D expenditures for the pharmaceutical industry and the semiconductor industry in 2004, and more than doubled R&D expenditures for computer and communications equipment manufacturing.

[8] The process is involves several steps to identify the NAICS industry: NSF (2002) page 123.
[9] NSF (2006).
[10] NSF InfoBrief (07-313). In addition to the wholesale trade classification, NSF identifies three other scenarios where the reclassification provides an improved industry alignment. These are where a company has global operations that have a different primary activity from the primary U.S. activity; where a firm outsources manufacturing operations so that its payroll is not primarily manufacturing; and where early stage companies are not yet producing products.

In order to create a consistent times series for these industries, a separate data series unaffected by the SIRD reclassification was used to smooth or "wedge" the impacts of this break over several years. Data from BEA's International Investment Division for R&D expenditures by U.S. parents (multinational companies) and by the U.S. based affiliates of foreign multinationals were used to aid the creation of the time series reclassification. These data are organized based on the industrial classification of the U.S. component of the MNC's activities. The basis for identifying the primary activity of an enterprise for industry classification purposes in the BEA data is sales rather than payroll, avoiding the payroll-based impact on industry classification that resulted in the allocation of manufacturing-related R&D to wholesale trade in the SIRD data in recent years. While the scope of NSF's SIRD survey is broader than that of BEA's data on U.S. MNCs and U.S. affiliates of foreign MNCs, a recent comparison of the two surveys found that 92% of BEA's published R&D spending by U.S MNCs parents linked to the firms in the RD-1 survey frame, and 80% of U.S. affiliates of foreign MNCs linked as well (Census, BEA, NSF/DSRS (2005)).

To illustrate the details of the adjustment, for chemicals manufacturing the reclassification for earlier years is implemented in the following way: An extrapolator composed of the R&D expenditures by U.S. parent companies and by U.S. based affiliates of foreign multinationals classified in the chemicals industry is developed and used to extrapolate forward and backward in time the 1999 and 2004 (post reclassification) NSF estimate of R&D expenditures funded by Federal, company and

other. The two resulting series are averaged together with weights that decrease proportionally as time moves further away from the known value.[11]

To split the result of this procedure between pharmaceuticals and other chemicals, NSF pre-reclassification expenditure data are used as weights for the years 2000, 2001, and 2002. For the year 2003 NSF provided an estimate of pharmaceutical manufacturing R&D performance on a reclassified basis (NSF (2006)).

Estimates of company and other funding are developed by subtracting reported Federally-funded R&D from the total estimates developed above. This approach is taken because the distribution of federally funded industry R&D is largely unaffected by the reclassification (NSF (2007)).

The expenditure data after reclassification for the wholesale trade adjustment is shown in Appendix tables 2.1 through 2.3. These estimates present a consistent NAICS time series for the years 1987-2004 on a company basis, including the adjustment to costs to convert depreciation to CFC.

2.7 Company to Establishment

BEA's GDP-by-industry estimates are based on industries classified by type of establishment. According to this establishment-based approach, a multiunit firm with one establishment whose main activity is manufacturing and another establishment whose main activity is R&D services will have the output of the manufacturing establishment

[11] This "double wedge" procedure is used at BEA to estimate an annual series between benchmarks with an extrapolator series—usually the annually sampled estimates of the same series for which the benchmark covers the complete universe. The forward extrapolated estimates have larger weights in the initial years; (for example, 80%, 60%, 40%, 20% where there are 4 intervening years) the backward extrapolated estimates have larger weights in the terminal years (20%, 40%, 60%, 80% for the same 4 years).

assigned to the manufacturing sector (the primary industry) and the output of its R&D services establishment assigned to the service sector.

In contrast, NSF's industry classification system assigns all of a multiunit company's R&D expenditures to one industry.[12] For a given company, these expenditures can be made in several different types of establishments. The types of establishments that can perform R&D include a manufacturing plant, a company headquarters building, a free-standing R&D lab that provides all its output to the company, or an R&D subsidiary that sells its R&D output. Since the SIRD does not link R&D expenditures to establishment types, using the SIRD industry category expenditures directly in estimates of industry gross output would imply that all pharmaceutical and medicine manufacturing R&D activity was conducted in manufacturing plants rather than spread to the industry's R&D labs, company headquarters facilities, manufacturing plants, and other types of establishments. This treatment would add the estimate of pharmaceutical and medicine manufacturing own-account R&D to the gross output of pharmaceutical and medicine manufacturing, rather than the establishments where the R&D was actually performed and the costs for the own- account R&D were incurred.

A special tabulation provided by Census is used to adjust the company data to improve the allocation of R&D output to establishment types. This tabulation for the year 2004 links employment and payroll data for establishments from the Business Register to the NSF's industry categories for the multiunit companies in the SIRD sample

[12] For companies with more than one establishment, data are summed to the company level and assigned a single NAICS code based on payroll. (Research and Development in Industry: 1999, NSF 02-312, Project Officer, Raymond M. Wolfe, Arlington VA 2002, Methodology Section, page 123)

frame.[13] This tabulation provides employment levels, payroll costs, and establishment counts for the types of establishments by NAICS industry that make up each company-based industry in the SIRD dataset.

Using this tabulation, SIRD data on R&D payroll, and Economic Census data on R&D, R&D payroll ratios are developed for two types of establishments that perform a large share of R&D within companies; these are scientific R&D labs and company headquarters. For each company-based industry, a ratio for R&D payroll costs in R&D labs from the Business Register (BR) to total R&D payroll costs from the SIRD is used to allocate a portion of R&D expenditures to the R&D labs (NAICS 5417):

$$\frac{BR\,Payroll_{5417}^{R\&D}}{SIRD\,Payroll_{all}^{R\&D}} Costs_{all}^{R\&D} = Costs_{5417}^{R\&D}$$

A similar ratio allocates R&D costs to company headquarters (NAICS 551) using the Business Register for establishment payroll, the SIRD for company R&D payroll, and data from the Economic Census (EC) on headquarters payroll that is R&D-related:

$$\frac{EC\,Payroll_{551}^{R\&D}}{EC\,Payroll_{551}} \frac{BR\,Payroll_{551}}{SIRD\,Payroll_{all}^{R\&D}} Costs_{all}^{R\&D} = Costs_{551}^{R\&D}$$

Although multiunit companies have other types of establishments in addition to R&D labs, company headquarters, and primary industry establishments, no source data are available to reallocate R&D performance by these establishments and no additional adjustment is made to reassign the R&D expenditures to other industries. All remaining R&D costs are assumed to be performed in the establishments of the "primary" industry.

[13] This tabulation was provided to BEA jointly by NSF and Census in order to improve the industry-level estimates for the R&D satellite account.

Table 2 shows the impact of these adjustments on the industry distribution of R&D performance for 2004. The share of R&D expenditures in the scientific R&D services industry rises from 5.5 percent when estimated on company basis to 21.1 percent when estimated on an establishment basis.

Although this company-to-establishment reclassification of R&D output reassigns R&D to the establishment where it is performed, the reassigned R&D investment is ultimately treated as investment for the primary industry. In the steps described below, the reassigned R&D is sold back to the primary industry, where it becomes a capital input to production.

3. Step by Step from Unadjusted VA to R&D-adjusted VA

3.1 Detailed GDP-by-industry Data

Because the industries detailed in this report are more highly disaggregated than current publication level of BEA's GDP-by-industry accounts, a special tabulation was prepared by the Industry Accounts staff using values from the Input-Output (I-O) accounts. This special tabulation consisted of estimates of gross outputs, intermediate inputs, value added, and price indexes for the years 1987 to 2004 at the four-digit NAICS level.

Current-dollar estimates for each of the unpublished four-digit NAICS industries (for example, NAICS 3344 "Semiconductors") were prepared separately for 1987-1996 and for 1997-2004. Estimates for 1987-1996 are derived by: First, extrapolating the revised 1997 NAICS benchmark levels for gross output, compensation of employees, "taxes on production and imports less subsidies," and gross operating surplus. Second,

detailed percentage-shares of the three-digit NAICS aggregates are used to compute a current-dollar level for the unpublished industry as a percentage of the published three-digit industry estimate. Third, current-dollar value added is computed as the sum of compensation of employees, "taxes on production and imports less subsidies," and gross operating surplus. Fourth, current-dollar intermediate inputs are computed residually, as the difference between current-dollar gross output and current-dollar value added. Estimates of gross output, intermediate inputs and value added for 1997 are from the revised 1997 benchmark I-O accounts; estimates for 1998-2004 are unpublished detail from the time series of annual I-O accounts.

Real estimates (chain-type quantity and price indexes) of gross output, intermediate inputs, and value added were prepared separately for 1987-1996 and for 1997-2004. For 1987-1996, after first computing Fisher price indexes for gross output by industry and for intermediate inputs by industry, real value added is computed using the double deflation method. Detailed SIC-based price indexes are generally available at the same level of detail as that used to extrapolate the revised 1997 benchmark estimates. For gross output, unpublished NAICS-based chain-type quantity indexes for 1997 were extrapolated back to 1987 using corresponding Fisher quantity relatives computed from the current-dollar value and the detailed price indexes. Residual intermediate purchases by industry were deflated at roughly the four-digit commodity level (approximately 130 commodities) based on a converted time series of benchmark-year use tables consistent with the revised 1997 benchmark use table. The double-deflation procedure used for these estimates is therefore similar to the procedure used for the integrated estimates;

however, the level of commodity detail for the deflation of intermediate inputs is at a higher level of aggregation.

For 1997-2004, real gross output and real intermediate inputs are unpublished NAICS chain-type quantity and price indexes from the integrated annual industry accounts. After preparing real gross output and real intermediate inputs from the revised 1997 benchmark and the 1998-2004 annual make and use tables, respectively, real value added estimates are prepared using the double deflation method.

3.2 Adjusting Gross Output for Own-Account R&D

Recognizing R&D as investment adds own-account R&D to gross output, and Table 3 shows the adjustments that translate the NSF expenditure data into measures of own-account R&D investment. The costs of own-account R&D are calculated as total costs for R&D performed (line 3 plus line 4), less the costs of R&D sold, and less the overlap with R&D expenditures currently included in capitalized own-account software (line 11). Federal funds for industry-performed R&D were calculated using cost-based data available from the SIRD. These cost-based measures for Federally-funded R&D have been adjusted in the same way that total expenditures have been adjusted—both for ccadj and to reassign the expenditures for R&D performed in R&D labs and company headquarters.[14]

For the transactions that follow, complete data are not available for each adjustment on a cost basis and therefore costs were estimated from available data on receipts or funding. This gap between funder's outlays and performer's costs is estimated

[14] The data here are suppressed to prevent the release of industry-specific international trade data, rather than to protect the data on Federal funds for R&D. Indeed, these data unadjusted for CFC are available from NSF.

with the net operating surplus of the miscellaneous professional, scientific, and technical services industry.[15] Funding or the sum of receipts for State and local government funding, other business purchases, and exports is converted to costs by subtracting the net operating surplus estimate.

The NIPA-based satellite account provides annual totals for State and local government funding of business R&D. Because no source data are available to distribute these annual totals to different industries, the Federal distribution was used as a proxy after excluding defense-related industry spending.

Costs are next removed for the R&D output that is sold to other domestic businesses or exported. The domestic component comes from NSF data on company and other nonfederal funds for R&D performed outside of company facilities in the United States by outside organizations, classified by industry and by type of organization. Industry exports of R&D services are estimates based on BEA data on a special tabulation of international trade in research, development and testing services for affiliated and unaffiliated enterprises. The transaction amounts for lines 6, 7, and 9 are suppressed to maintain the confidentiality of the BEA data on industry-specific international trade transactions.

Estimates of trade in R&D services come from BEA data collected for use in the international transaction accounts on receipts and payments of Research, Development, and Testing (RDT) services.[16] The estimates of R&D exports and imports are drawn

[15] This is an industry category from BEA's GDP-by-Industry data that contains Scientific R&D services (NAICS 5417) within it as a sub-industry. Net Operating Surplus is estimated as Gross Operating Surplus less CFC, and thus reflects a residual profit-like measure for the industry.

[16] 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 of prototypes, but not

from BEA's published time series of unaffiliated payments and receipts for RDT services (1987-2004) and the shorter series of affiliated payments and receipts for RDT services (2001-2004).

For the unaffiliated trade (trade between unrelated companies), a subset of the unpublished data for the years 1997-2004 from the BE-25 and BE-22 surveys is used to create time series for each of the 14 industries of the industry satellite account. These data are classified by industry based on gross receipts for the entire company. To be consistent with NSF's 2004 wholesale trade reclassification, RDT services receipts and payments reported by drug wholesalers (NAICS 4222) are reclassified into pharmaceutical manufacturing (NAICS 3254). For years prior to 1997, the industry distribution for 1997 is held constant.

For affiliated trade (trade within a multinational corporation), insufficient information is available to assign these transactions to industries directly. Instead, BEA's International Investment Division provided a proxy industry distribution for the total affiliated payments and receipts. This proxy distribution is based on the industry classification of reported R&D expenditures collected in BEA's direct investment abroad and foreign direct investment surveys. For U.S. parents and for U.S. affiliates, both receipts and payments are distributed proportionally across industries to R&D expenditures. In order to align these receipts and payments with NSF's 2004 reclassification adjustment for wholesale trade, the adjustments described in the unaffiliated section above for drug wholesalers are applied to the affiliated transactions.

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routine testing. Thus the RDT services data may include non-R&D transactions of unknown, but likely small magnitude.

The time series developed to proxy R&D exports and imports in the R&D satellite account should be considered a first approximation, providing a preliminary cut at the issues related to R&D services trade that BEA will need to address before incorporating R&D as investment into the core accounts. Particular future consideration should be given to the treatment of intra-firm (affiliated) trade in RDT services. While the current implementation of the satellite account includes the adjustments described above for both affiliated and unaffiliated R&D trade, an alternative case could be made for excluding the affiliated trade component because of the ambiguity involved in assessing national ownership and the potential for non-rival use within firms.[17]

In the estimation of adjusted gross output in Table 3, after these cost components are removed, the residual is the estimate of own-account R&D for the industry (line 2). Adjusted gross output is then the sum of own-account R&D (line 2) and unadjusted gross output (line 12), less the R&D software double-count adjustment (line 11).

3.3 Adjustments to Intermediate Inputs for Purchased R&D

The second half of the adjustment to value added is the impact of purchased R&D, calculated by adjusting each industry's intermediate inputs to subtract purchases for R&D. Intermediate inputs are lower because the expenditures that had been treated as current expenses are now treated as investment, thus current expenses and intermediate inputs fall. Limited source data are available to accurately allocate purchased R&D to industries that pay for it and use it in production. The procedure described below relies heavily on unpublished data developed for the NIPA-based R&D satellite account on the

[17] For a detailed discussion see Yorgason (2007): "Treatment of International Research and Development as Investment, Issues and Estimates," http://www.bea.gov/papers/pdf/yorgason_rd_paper.pdf

sources of R&D funding by sector, and on SIRD data that identifies company expenditures for R&D performed by other businesses and other sectors.

The first step for intermediate inputs involves the adjustment to the NSF data described earlier as the company to establishment adjustment. The primary industry here "buys back" the R&D performed in R&D labs and headquarters within the firm. This step consists of two different transactions between the R&D establishment and the primary industry. For each industry, the portion of R&D investment that is transferred from auxiliary units and purchased from subsidiary units is separately estimated. The first type of transaction, auxiliary R&D for each primary industry, is characterized as the situation where the R&D establishment provides all its output to the establishments of the primary industry. Without specific data to separate these types of R&D, the ratio below is used, where the R&D investment from 5417 auxiliaries serving industry *(i)* is estimating using the overall ratio of all auxiliary 5417 output to the sum of auxiliary 5417 output plus other for-profit 5417 output:

$$Auxiliary\ R\&D_i^{5417}\ Investment = \frac{Auxiliary R\&D^{5417} Output}{Auxiliary + \ forprofit R\&D^{5417} Output}(R\&D_i^{5417}\ Investment)$$

In the Economic Census and in GDP-by-industry data, this auxiliary output is estimated as the sum of costs. This treatment is maintained here, so R&D in auxiliary units is "sold" or transferred back to the primary industry at cost. The second type of output is a sale between an R&D subsidiary and the establishments of the primary industry. The subsidiary is assumed to sell its R&D output both outside the company as well as within the company. This transaction is estimated at the price paid by the final

user (purchasers' price), and so a profit margin is added to the costs, using the net operating surplus of the miscellaneous professional, scientific, and technical services industry.

Line 17 reflects a relatively small additional R&D investment not currently captured in NSF R&D expenditures: These purchases of NAICS 54172 are purchases of research and development services in the social sciences. This R&D is within the Frascati Manual definition of R&D that BEA has adopted for the satellite account, but is not currently measured in the SIRD, which is limited to R&D in science and engineering. This estimate is based on Economic Census and Service Annual Survey data for social science R&D. Because there is no parallel estimate for own-account social science R&D, this is considered to be just a fraction of the total scope of business R&D in social sciences and humanities that would fall within the scope of capitalized R&D.

Business purchases from outside of the company are assumed to be transacted at prices paid by purchasers, and this step relies heavily on NSF data on company and other funds for industrial R&D performed outside of company facilities. This information is found in SIRD Table 12 for 2004, and is hereafter referred to as "SIRD Table 12." SIRD Table 12 provides the detail used in the next three lines of Table 3 of this paper to identify detailed industry funding of R&D by other performers. These transactions are assumed to be reported at the price paid by the final user.

When total industry funding for another performer is available from the R&D satellite account, for example for academic R&D funded by business, this information is used, and only the distribution of this total across industries is drawn from SIRD Table 12. For R&D funded by business and performed by academic institutions, non-profit

institutions, and state and local governments, the business funding totals from the aggregate satellite account are used. In each case only the distribution across industries comes from SIRD Table 12. No total is available, however, for R&D purchased from unrelated for-profit companies, and so the total as well as the distribution from SIRD Table 12 is used in Line 22.

Similar to the R&D exports, data on imports of R&D are based on BEA measures of international trade in research, development and testing services for affiliated and unaffiliated enterprises. The sum of each industry's purchases and funding of R&D by other performers is equal to its purchased R&D (line 14), and intermediate inputs fall by this amount when R&D is treated as investment. Total industry investment in R&D is both purchased R&D and own-account (line 27). The change in industry value added due to private business R&D equals this newly recognized R&D investment less the overlap between R&D and own-account software investment (line 25).

Limitations of the Estimates

The methodology presented here is a first attempt to address the implementation challenges that BEA faces in the incorporation of R&D as investment in the full set of industry accounts. The main limitation of the methodology is that insufficiently detailed data are available on the economic transactions related to R&D activity between funders and performers. Most of the detailed data used here have been collected on a performer basis; the national accounts present measures of investment by the owners, therefore detailed data are need from the perspective of the funder of investment.

Because of the paucity of data for economic measurement, the experimental methodology relied heavily on estimating ratios that were based on similar transactions. An example of this is that the cost of exported R&D is estimated using receipts for R&D exports and the ratio of net operating surplus to gross output for miscellaneous professional, scientific, and technical industries. This ratio, while insufficiently detailed, could be updated annually based on BEA data sources.

For other ratios, data from recent years are used to extrapolate relationships for the entire time series 1987-2004. An example of this is the ratio used to reallocate R&D performed in R&D labs and company headquarters; these ratios are based on 2004 data and applied to the entire time series 1987-2004. For this reason, the quality of the estimates produced with this methodology should be considered to be more robust for the period 2000-2004, and less robust in earlier years. While the 1987-2004 time series can also be extended back on a NAICS basis, dependent on backcast estimates of industry gross output and intermediate inputs at an appropriate aggregation level, the quality of these estimates will be dependent on the ratios or other extrapolators used for unobserved transactions.

Even with these methods, some components of the estimates could not be allocated to industries at all. An example of this is the procedure used to allocate the R&D output of multi-unit firms to the types of establishments where the R&D is performed. The methodology described in this paper allocates R&D output to R&D labs and company headquarters with reasonable precision. The residual is allocated to the primary industry. For industries where most R&D is used directly by the primary industry, this misclassified R&D output is likely of small magnitude. For horizontally

integrated firms that produce several different types of manufactured products or lines of business, the misclassification is likely to be more substantial. Improved source data will ultimately be needed in order to more accurately allocate company-based R&D investment across different lines of business within multiunit firms.

Improved source data will also be necessary to estimate the own-account component of social science and humanities-related R&D investment. The estimates included in this year's effort embrace only the component of the output of social science R&D establishments that is sold, while own-account social science R&D may be quite substantial.

In the near term, further work with the SIRD microdata can improve the 2004 wholesale trade industry reclassification, the company to establishment adjustment, and provide better information for historical estimates. For a full set of input-output tables, additional work needs to be done to identify not only the purchasers of R&D investment, but also the industries that use or rent R&D through royalties and licensing fees. The upcoming redesign of the SIRD is also slated to yield substantially improved data for the economic measurement of R&D activity. However, because SIRD is only directed towards companies that perform R&D, the purchase of R&D and payments for its use through royalties and licensing fees by companies that do not perform R&D themselves will need to be obtained from other sources.

In addition to the need for improved data on transactions for R&D between companies, a full accounting of R&D investment in the U.S. economy will require improved estimates of the use of R&D within firms. At present limited information is available to properly allocate R&D to users within companies. While this issue exists for

other assets, the intangible qualities of R&D intensify the difficulty in locating the using industry, and the public goods qualities of R&D make it more likely that firms will produce R&D internally rather that purchase it.

Conclusion

This methodology paper describes the construction of the experimental GDP-by-industry estimates of the impact of treating R&D as investment for a subset of R&D intensive industries for the years 1987-2004. The comprehensive methodology developed provides a first cut at these estimates and shows that incorporating R&D as investment into the industry accounts is feasible. The full incorporation of R&D as investment in the supply, use, and capital flow tables would provide a rich resource for tracing the inter-industry flows of technology and innovation through the domestic economy. However, many data-related challenges will need to be resolved before the detailed transactions between industries can be incorporated into the standard set of published industry accounts.

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Table 1. Industry Value Added Impact of Treating Business Expenditures for R&D as Investment , Pharmaceutical and Medicine Manufacturing, 2004, $billions

	Unadjusted	Adjustment	Adjusted
Gross output	155.4		166.2 *
Plus: Own account R&D		10.9	
Intermediate Inputs	83.7		54.0
Less: Purchased R&D		29.7	
Value Added	71.7		112.2
Addendum: R&D investment		40.6	

* Includes a 0.1 billion dollar adjustment for the overlap between own-account R&D and own-account software.

Table 2. Industry shares in 2004 based on NSF company classifications and BEA's establishment adjustments

Industry share of NSF reported total expenditures, NSF's revised industry classification					Industry Share of expenditures adjusted for CCADJ, with 5417 and 551 moved to establishment-based industry		
		2004R				2004 adjusted	
	Total R&D Expenditures (millions)	208,301	100.0%		Total R&D Expenditures w/ CCADJ (millions)	211,591	100.0%
3254	Pharmaceutical and medicine manufacturing	31,477	15.1%		Pharmaceutical and medicine manufacturing	13,460	6.4%
3251-53, 3255-56,3259	Chemicals minus pharmaceutical and medicine manufacturing	7,938	3.8%		Chemicals minus pharmaceutical and medicine manufacturing	5,886	2.8%
3341	Computer and peripheral equipment manufacturing	5,734	2.8%		Computer and peripheral equipment manufacturing	5,315	2.5%
3342	Communications equipment manufacturing	8,654	4.2%		Communications equipment manufacturing	7,284	3.4%
3344	Semiconductor and other electronic component manufacturing	17,546	8.4%		Semiconductor and other electronic component manufacturing	16,616	7.9%
3345	Navigational, measuring, electro-medical , & control instruments manufacturing	15,214	7.3%		Navigational, measuring, electro-medical , & control instruments manufacturing	14,157	6.7%
3343, 3346	Other computer and electronic products manufacturing	1,148	0.6%		Other computer and electronic products manufacturing	1,063	0.5%
3361-3363	Motor vehicles, bodies and trailers, and parts manufacturing	15,677	7.5%		Motor vehicles, bodies and trailers, and parts manufacturing	11,935	5.6%
3364	Aerospace product and parts manufacturing	13,086	6.3%		Aerospace product and parts manufacturing	11,654	5.5%
3365-66, 3369	Other transportation equipment manufacturing	4,505	2.2%		Other transportation equipment manufacturing	4,153	2.0%
5112	Software publishers	16,566	8.0%		Software publishers	16,703	7.9%
5415	Computer systems design and related services	11,575	5.6%		Computer systems design and related services	11,010	5.2%
5417	Scientific R&D services	11,355	5.5%		Scientific R&D services	44,571	21.1%
	SUM	160,475	77.0%		SUM	163,807	77.4%
	All other for-profit industries	47,826	23.0%		All other for-profit industries	47,784	22.6%

Table 3. Gross Output, Intermediate Inputs and Value Added for Pharmaceutical and Medicine Manufacturing, Unadjusted and Adjusted for R&D as Investment, 1987 and 2004 (continues)

Line	Steps	Description	1987	2004
			(Millions of dollars)	
1	**Industry gross output before adjustments**	**Tabulation of BEA GDP-by-industry data, including unpublished detail**[1]	**38,267**	**155,409**
2	**Plus own-account R&D investment, which is calculated as:**		**1,192**	**10,891**
3	National Science Foundation (NSF) R&D expenditures from the Survey of Industrial R&D (SIRD)[2]	Funds for industrial R&D performed in the United States.[3] The value for 1987 is estimated based on 1987 SIRD data for the SIC-based drugs and medicines industry using standard BEA methods for (a) converting SIC data to NAICS and (b) estimating suppressed values.	3,603	31,477
4	Plus adjustments to account for the full cost of production and to create a consistent time series	(1) A capital consumption adjustment is made to convert business depreciation to the national accounting concept--consumption of fixed capital (CFC). (2) Expenditures for Federally-funded research and development centers (FFRDCs) are removed for years when they are included in the industry performance total.	66	454
5	Less the establishment "carve- out": R&D performed in company headquarters (NAICS 551), R&D services subsidiary establishments, and auxiliary R&D services establishments (both in NAICS 5417).	This estimate is based on R&D payroll in company headquarters (NAICS 551) and R&D services subsidiary establishments, and auxiliary R&D services establishments (both in NAICS 5417), using unpublished data from the Bureau of the Census and SIRD.	2,122	18,471
6	Less the cost of R&D funded by the Federal government	Federally-funded industry performed R&D adjusted for CFC.[3]	(D)	(D)
7	Less the cost of R&D funded by state and local (S&L) governments	Total funding estimated in the NIPA-based R&D satellite account, less an estimate of the gap between funder outlays and costs.[4] Total costs distributed across industries using the distribution of Federally-funded R&D, excluding the aerospace product and parts manufacturing industry (NAICS 3364) and the navigational, measuring, electromedical, and control instruments manufacturing industry (NAICS 3345). These types of R&D are assumed to be primarily defense related.	(D)	(D)
8	Less the cost of R&D funded by non-profit institutions serving households	Assumed to be zero.	0	0
9	Less the cost of: (1) R&D sold to other domestic businesses and (2) exported R&D	For both domestic purchases and exports, costs are calculated for this step using an estimate of the gap between funder outlays and costs.[4] Total R&D sold to other domestic businesses is estimated with industry purchases from other domestic for-profit companies. The industry is assumed to sell R&D in proportion to their performance.[5] Cost of exports based on BEA international services trade data for research, development, and testing services.[6]	(D)	(D)
10	Plus R&D expenses to create software that are not accounted for in NSF data	Special tabulation of BEA own-account software R&D. These expenses are added for time series consistency. They are removed in the step below in the double-count adjustment.	12	No adjustment necessary
11	Less the double-counting of own-account R&D software investment	For 1987, a special tabulation of BEA own-account software data was performed. For 2004, values come from SIRD.[7]	12	106
12	**Equals gross output adjusted for own-account R&D as investment**		**39,447**	**166,194**
13	**Intermediate inputs before capitalization**	**Tabulation of GDP-by-industry data, including unpublished detail.**[1]	**23,134**	**83,697**

Table 3. Gross Output, Intermediate Inputs and Value Added for Pharmaceutical and Medicine Manufacturing, Unadjusted and Adjusted for R&D as Investment, 1987 and 2004, continued

14	**Less total purchased R&D, calculated as the sum of:**		**4,377**	**29,706**
15	Cost of R&D performed in a company headquarters (NAICS 551) or R&D services auxiliary (NAICS 5417) and transferred for use in pharmaceutical and medicine manufacturing establishments (part of the establishment carve-out)	The costs incurred in NAICS 5417 and NAICS 551 establishments, described in line 5 above, are transferred as the sum of production costs. The auxiliary establishment component of NAICS 5417 output is estimated with the ratio of auxiliary output to total private output of NAICS 5417 data from the Economic Census.	1,203	8,447
16	Plus R&D purchased from a R&D services (NAICS 5417) domestic subsidiary for use in pharmaceutical and medicine manufacturing establishments (part of the establishment carve-out)	NAICS 5417 carve-out (see line 5). This carve-out is adjusted with an estimate of the gap between receipts and costs to represent the purchase value of R&D output. [4]	1,189	11,743
17	Plus purchases of non-science and engineering R&D from for-profit R&D services establishments (NAICS 54172)	Total purchases for all industries are based on BEA's annual input-output values. Capitalized R&D should include social science R&D and this measure provides a partial estimate. This industry share is proxied with the distribution of business purchases of R&D from non-profits and universities and colleges from SIRD. [5]	663	2,251
18	Plus industry-funded R&D performed by academic institutions	Total for all industries from unpublished detail from the NIPA-based R&D satellite account estimate. Industry share comes from SIRD data on company-funded R&D performed by universities and colleges.5	443	1,215
19	Plus industry-funded R&D performed by non-profit institutions serving households	Total for all industries from unpublished detail from the NIPA-based R&D satellite account estimate. Industry share comes from SIRD data on company-funded R&D performed by non-profit organizations (other than universities and colleges). [5]	144	360
20	Plus industry-funded R&D performed by FFRDCs	Total for all industries from unpublished detail from the NIPA-based R&D satellite account estimate. Industry share assumes that the same industries purchase R&D from FFRDCs as perform R&D for the Federal government.	(D)	(D)
21	Plus industry-funded R&D performed by S&L governments	Total for all industries from unpublished detail from the NIPA-based R&D satellite account estimate. Industry share is proxied with SIRD data on company-funded R&D performed by academic and non-profit organizations. [5]	(D)	(D)
22	Plus: (1) domestic purchases of R&D from other for-profit companies and (2) imports of R&D	Industry purchases are estimated based on SIRD data on business purchases of R&D from other domestic for-profit companies. [5] Industry imports are estimated based on BEA data on international trade in R&D services. [6]	(D)	(D)
23	**Intermediate inputs including R&D adjustments (line 13 less line 14)**		**18,757**	**53,990**
24	**Value added before adjustments (line 1 less line 13)**	**Tabulation of BEA GDP-by-industry data, including unpublished detail.** [1]	**15,133**	**71,712**
25	Plus total R&D investment less the double-counting of own-account R&D software investment (line 2 plus line 14 less line 10)	For 1987, own-account R&D software investment values are BEA estimates. For 2004, values come from SIRD. [7]	5,557	40,491
26	**Value added including R&D adjustments (line 12 less line 23)**		**20,690**	**112,204**
27	**Addendum: Total R&D investment including software R&D**		**5,569**	**40,597**

GDP Gross domestic product
NIPAs National income and product accounts

NAICS North American Industry Classification System
R&D Research and development
SIC Standard Industrial Classification

D Suppressed to avoid disclosure of data from individual companies.

1. BEA GDP-by-industry data are available at <www.bea.gov/industry/gdp

2. NSF SIRD data are available at <www.nsf.gov/statistics/industry>. Historical data are provided in the Industrial Research and Development Information System at <www.nsf.gov/statistics/iris>.

3. 2004 SIRD, Table 1.

4. Estimated with the ratio of net operating surplus to gross output for miscellaneous professional, scientific, and technical services (NAICS 5412OP) from BEA's GDP-by-industry data, various years.

5. 2004 SIRD, Table 12.

6. BEA international services trade data are available at <www.bea.gov/international/intlserv.htm>. Industry detail is based on a tabulation of unpublished data for the years 1997-2004 for both affiliated and unaffiliated trade.

7. 2004 SIRD, Table 7.

Appendix Table 1.1 R&D Expenditures in the United States: Total (Company & Other and Federally Funded), 1987–2004
(Millions of dollars, Calendar year basis)

NAICS code	Industry	1987	1988	1989	1990	1991	1992	1993	1994	1995
	All for-profit industries	**90,160**	**94,894**	**99,860**	**107,404**	**114,674**	**116,758**	**115,438**	**117,393**	**129,830**
325	**Chemical manufacturing**	***8,342***	***9,541***	***10,434***	***11,459***	***12,686***	***13,378***	***14,666***	***14,743***	***15,269***
3254	Pharmaceutical and medicine	*3,603*	*4,293*	*4,849*	*5,190*	*6,145*	*7,013*	*8,071*	*8,596*	*9,022*
3251-53, 3255-56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	*4,739*	*5,248*	*5,585*	*6,269*	*6,541*	*6,365*	*6,594*	*6,147*	*6,247*
334	**Computer and electronic product manufacturing**	***17,450***	***16,993***	***16,739***	***17,908***	***19,276***	***19,965***	***18,265***	***20,755***	***25,029***
3341	Computer and peripheral equipment manufacturing	*4,096*	*3,989*	*3,929*	*4,204*	*4,525*	*4,687*	*4,288*	*4,872*	*5,875*
3342	Communications equipment	*1,504*	*1,465*	*1,443*	*1,544*	*1,662*	*1,721*	*1,575*	*1,789*	*2,158*
3344	Semiconductor and other electronic component manufacturing	*7,448*	*7,253*	*7,145*	*7,643*	*8,227*	*8,521*	*7,796*	*8,859*	*10,683*
3345	Navigational, measuring, electromedical, and control instruments manufacturing	*4,123*	*4,015*	*3,955*	*4,231*	*4,554*	*4,717*	*4,315*	*4,904*	*5,913*
3343, 3346	Other computer and electronic products manufacturing	*279*	*271*	*267*	*286*	*308*	*319*	*292*	*332*	*400*
336	**Transportation equipment manufacturing**	***36,151***	***36,447***	***35,127***	***32,097***	***27,731***	***27,796***	***27,518***	***27,969***	***32,548***
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	*10,230*	*10,801*	*11,593*	*10,685*	*10,809*	*10,881*	*12,175*	*13,819*	*15,549*
3364	Aerospace product and parts	*25,193*	*24,925*	*22,873*	*20,811*	*16,447*	*16,440*	*14,912*	*13,753*	*16,522*
3365-66, 3369	Other transportation equipment manufacturing	*728*	*720*	*661*	*601*	*475*	*475*	*431*	*397*	*477*
5112	**Software publishers**	*818*	*1,131*	*1,347*	*1,728*	*2,278*	*2,409*	*3,040*	*3,170*	*3,634*
5415	**Computer systems design and related services**	*436*	*600*	*816*	*1,213*	*1,755*	*1,801*	*1,989*	*1,913*	*2,118*
5417	**Scientific R&D services**	*1,574*	*2,111*	*2,840*	*4,232*	*5,775*	*5,855*	*6,202*	*5,684*	*5,540*
	All other for-profit industries	*25,390*	*28,071*	*32,558*	*38,766*	*45,173*	*45,553*	*43,758*	*43,158*	*45,693*

NAICS code	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004 Original Methodology	2004 Revised Methodology
	All for-profit industries	**142,370**	**155,409**	**167,102**	**182,180**	**200,007**	**202,017**	**193,868**	**200,724**	**208,301**	**208,301**
325	**Chemical manufacturing**	***15,506***	**16,492**	**18,969**	**20,246**	**20,918**	**17,892**	**20,641**	**23,001**	**23,023**	**39,415**
3254	Pharmaceutical and medicine	*8,642*	10,213	9,601	12,236	12,793	10,137	14,186	15,974	15,935	31,477
3251-53, 3255-56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	*6,864*	6,279	9,368	8,010	8,125	7,755	6,455	7,027	7,088	7,938
334	**Computer and electronic product manufacturing**	***29,277***	**33,988**	**38,209**	**37,350**	**47,520**	**50,591**	**38,881**	**39,001**	**29,963**	**48,296**
3341	Computer and peripheral equipment manufacturing	*6,873*	7,978	8,280	4,126	5,162	3,178	3,040	2,587	2,543	5,734
3342	Communications equipment	*2,524*	2,930	8,974	7,421	14,039	19,019	9,739	9,198	3,529	8,654
3344	Semiconductor and other electronic component manufacturing	*12,496*	14,507	9,131	10,701	12,894	14,358	11,919	12,635	8,843	17,546
3345	Navigational, measuring, electromedical, and control instruments manufacturing	*6,917*	8,030	11,232	14,337	15,116	12,947	13,729	14,014	14,079	15,214
3343, 3346	Other computer and electronic products manufacturing	*468*	543	592	765	309	1,090	454	567	969	1,148
336	**Transportation equipment manufacturing**	***32,985***	**32,565**	**29,547**	**32,266**	**28,450**	**25,965**	**26,145**	**31,747**	**32,535**	**33,268**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	*16,740*	16,095	14,603	18,876	19,022	17,207	15,563	17,471	14,969	15,677
3364	Aerospace product and parts	*15,789*	16,008	14,547	12,726	8,684	7,868	9,654	13,205	13,086	13,086
3365-66, 3369	Other transportation equipment manufacturing	*456*	462	397	664	744	890	928	1,071	4,480	4,505
5112	**Software publishers**	*6,328*	7,242	9,255	10,931	12,639	13,111	12,927	15,149	15,130	16,566
5415	**Computer systems design and related services**	*2,539*	3,172	3,092	4,217	5,169	9,154	11,983	9,032	6,309	11,575
5417	**Scientific R&D services**	*5,681*	6,818	8,862	10,283	12,651	14,244	13,034	12,460	15,264	11,355
	All other for-profit industries	*50,053*	55,132	59,168	66,887	72,659	71,060	70,257	70,334	86,077	47,826

Source is the National Science Foundation Survey of Industrial R&D, various years
NAICS North American Industry Classification S
R&D Research and development
Notes: The 1987-96 data are converted/backcast and the 1997-2004 are the NSF reported data.
Data exclude the industry administered federally funded research and development centers (FFRDCs) for the period 1987-2004.
These data exclude the adjustment for consumption of fixed capital.

Appendix Table 1.2 R&D Expenditures in the United States: Company and Other Funds for Industrial R&D, 1987–2004
(Millions of dollars, Calendar year basis)

NAICS code	Industry	1987	1988	1989	1990	1991	1992	1993	1994	1995
	All for-profit industries	**61,403**	**66,673**	**73,502**	**81,602**	**90,579**	**94,388**	**94,591**	**97,132**	**108,651**
325	**Chemical manufacturing**	**8,288**	**9,479**	**10,366**	**11,385**	**12,604**	**13,291**	**14,571**	**14,647**	**15,170**
3254	Pharmaceutical and medicine manufacturing	**3,603**	**4,293**	**4,849**	**5,190**	**6,145**	**7,013**	**8,071**	**8,596**	**9,022**
3251-53, 3255-56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	**4,685**	**5,186**	**5,517**	**6,195**	**6,458**	**6,278**	**6,499**	**6,051**	**6,148**
334	**Computer and electronic product manufacturing**	**13,499**	**13,920**	**13,937**	**14,448**	**14,623**	**15,577**	**15,487**	**17,343**	**21,533**
3341	Computer and peripheral equipment manufacturing	**3,508**	**3,618**	**3,622**	**3,755**	**3,800**	**4,048**	**4,025**	**4,507**	**5,596**
3342	Communications equipment manufacturing	**1,250**	**1,289**	**1,291**	**1,338**	**1,355**	**1,443**	**1,435**	**1,606**	**1,995**
3344	Semiconductor and other electronic component manufacturing	**6,378**	**6,578**	**6,585**	**6,827**	**6,910**	**7,361**	**7,318**	**8,195**	**10,175**
3345	Navigational, measuring, electromedical, and control instruments manufacturing	**2,118**	**2,184**	**2,186**	**2,267**	**2,294**	**2,444**	**2,430**	**2,721**	**3,378**
3343, 3346	Other computer and electronic products manufacturing	**244**	**252**	**252**	**261**	**264**	**282**	**280**	**314**	**389**
336	**Transportation equipment manufacturing**	**15,407**	**15,794**	**16,339**	**15,808**	**16,434**	**18,283**	**18,271**	**19,236**	**20,822**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	**7,609**	**8,185**	**9,073**	**8,742**	**9,200**	**9,402**	**10,852**	**12,143**	**13,764**
3364	Aerospace product and parts manufacturing	**7,396**	**7,218**	**6,891**	**6,703**	**6,862**	**8,424**	**7,005**	**6,697**	**6,664**
3365-66, 3369	Other transportation equipment manufacturing	**401**	**392**	**374**	**364**	**372**	**457**	**415**	**396**	**394**
5112	**Software publishers**	**704**	**989**	**1,210**	**1,652**	**2,210**	**2,319**	**2,937**	**3,054**	**3,537**
5415	**Computer systems design and related services**	**264**	**563**	**758**	**1,113**	**1,604**	**1,646**	**1,821**	**1,742**	**1,933**
5417	**Scientific R&D services**	**555**	**503**	**969**	**1,979**	**2,951**	**3,009**	**3,034**	**3,123**	**3,287**
	All other for-profit industries	**22,686**	**25,425**	**29,924**	**35,217**	**40,155**	**40,262**	**38,470**	**37,986**	**42,369**

NAICS code	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004 Original Methodology	2004 Revised Methodology
	All for-profit industries	**121,017**	**133,611**	**145,016**	**161,594**	**182,844**	**185,118**	**177,467**	**182,926**	**188,035**	**188,035**
325	**Chemical manufacturing**	**15,406**	**16,385**	**18,733**	**20,051**	**20,768**	**17,713**	**20,395**	**22,693**	**22,682**	**39,070**
3254	Pharmaceutical and medicine manufacturing	**8,642**	**10,213**	**9,601**	**12,236**	**12,793**	**10,137**	**14,186**	**15,949**	**15,906**	**31,444**
3251-53, 3255-56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	**6,763**	**6,172**	**9,132**	**7,815**	**7,975**	**7,576**	**6,209**	**6,744**	**6,776**	**7,626**
334	**Computer and electronic product manufacturing**	**25,153**	**29,698**	**31,872**	**31,357**	**41,976**	**44,744**	**33,411**	**32,494**	**22,406**	**40,690**
3341	Computer and peripheral equipment manufacturing	**6,537**	**7,718**	**8,276**	**4,126**	**5,162**	**3,165**	**3,015**	**2,561**	**2,517**	**5,707**
3342	Communications equipment manufacturing	**2,330**	**2,751**	**8,456**	**7,215**	**13,606**	**18,721**	**9,524**	**8,932**	**3,356**	**8,433**
3344	Semiconductor and other electronic component manufacturing	**11,885**	**14,033**	**9,072**	**10,624**	**12,787**	**14,210**	**11,871**	**12,607**	**8,821**	**17,524**
3345	Navigational, measuring, electromedical, and control instruments manufacturing	**3,946**	**4,659**	**5,483**	**8,632**	**10,114**	**7,565**	**8,549**	**7,834**	**6,747**	**7,882**
3343, 3346	Other computer and electronic products manufacturing	**455**	**537**	**585**	**760**	**307**	**1,083**	**452**	**560**	**965**	**1,144**
336	**Transportation equipment manufacturing**	**22,336**	**21,713**	**20,677**	**23,928**	**22,917**	**21,004**	**21,453**	**25,757**	**25,276**	**26,019**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	**14,925**	**14,340**	**13,781**	**17,987**	**18,306**	**16,089**	**15,199**	**16,874**	**14,903**	**15,610**
3364	Aerospace product and parts manufacturing	**6,996**	**6,961**	**6,521**	**5,309**	**3,895**	**4,083**	**5,349**	**7,849**	**9,224**	**9,224**
3365-66, 3369	Other transportation equipment manufacturing	**414**	**412**	**375**	**632**	**716**	**832**	**905**	**1,034**	**1,149**	**1,185**
5112	**Software publishers**	**6,287**	**7,194**	**9,188**	**10,882**	**12,561**	**13,067**	**12,874**	**15,095**	**15,074**	**16,510**
5415	**Computer systems design and related services**	**2,396**	**2,995**	**2,861**	**3,989**	**4,943**	**8,656**	**10,394**	**8,613**	**6,074**	**11,197**
5417	**Scientific R&D services**	**3,808**	**4,688**	**6,446**	**7,413**	**9,715**	**10,893**	**10,735**	**10,574**	**13,258**	**9,383**
	All other for-profit industries	**45,631**	**50,938**	**55,239**	**63,974**	**69,964**	**69,041**	**68,205**	**67,700**	**83,265**	**45,166**

Source: National Science Foundation Survey of Industrial R&D, various years
NAICS North American Industry Classification System
R&D Research and development
Notes: The 1987-96 data are converted/backcast and the 1997-2004 are the NSF reported data.
Data exclude the industry administered federally funded research and development centers (FFRDCs) for the period 1987-2004.
These data exclude the adjustment for consumption of fixed capital.

Appendix Table 1.3 R&D Expenditures in the United States: Federally Funded, 1987–2004
(Millions of dollars, Calendar year basis)

NAICS code	Industry	1987	1988	1989	1990	1991	1992	1993	1994	1995
	All for-profit industries	**28,757**	**28,221**	**26,358**	**25,802**	**24,095**	**22,370**	**20,847**	**20,262**	**21,179**
325	**Chemical manufacturing**	**54**	**62**	**68**	**74**	**82**	**87**	**95**	**96**	**99**
3254	Pharmaceutical and medicine manufacturing	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3251-53, 3255-56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	**54**	**62**	**68**	**74**	**82**	**87**	**95**	**96**	**99**
334	**Computer and electronic product manufacturing**	**3,951**	**3,073**	**2,803**	**3,460**	**4,654**	**4,387**	**2,778**	**3,413**	**3,496**
3341	Computer and peripheral equipment manufacturing	**588**	**371**	**308**	**449**	**725**	**638**	**263**	**365**	**279**
3342	Communications equipment manufacturing	**254**	**175**	**152**	**205**	**307**	**278**	**140**	**183**	**163**
3344	Semiconductor and other electronic component manufacturing	**1,069**	**675**	**559**	**816**	**1,318**	**1,161**	**478**	**664**	**508**
3345	Navigational, measuring, electromedical, and control instruments manufacturing	**2,005**	**1,831**	**1,768**	**1,964**	**2,260**	**2,273**	**1,886**	**2,183**	**2,535**
3343, 3346	Other computer and electronic products manufacturing	**35**	**20**	**15**	**25**	**44**	**37**	**12**	**18**	**11**
336	**Transportation equipment manufacturing**	**20,744**	**20,652**	**18,788**	**16,289**	**11,298**	**9,513**	**9,247**	**8,734**	**11,726**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	**2,621**	**2,617**	**2,520**	**1,944**	**1,609**	**1,479**	**1,323**	**1,676**	**1,785**
3364	Aerospace product and parts manufacturing	**17,797**	**17,708**	**15,982**	**14,108**	**9,585**	**8,016**	**7,907**	**7,056**	**9,858**
3365-66, 3369	Other transportation equipment manufacturing	**326**	**328**	**287**	**237**	**103**	**18**	**16**	**1**	**83**
5112	**Software publishers**	**114**	**142**	**137**	**76**	**69**	**90**	**103**	**116**	**96**
5415	**Computer systems design and related services**	**172**	**37**	**58**	**99**	**151**	**155**	**167**	**171**	**185**
5417	**Scientific R&D services**	**1,019**	**1,609**	**1,871**	**2,253**	**2,824**	**2,846**	**3,168**	**2,561**	**2,253**
	All other for-profit industries	**2,704**	**2,646**	**2,634**	**3,549**	**5,018**	**5,291**	**5,288**	**5,172**	**3,324**

NAICS code	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004 Original Methodology	2004 Revised Methodology
	All for-profit industries	**21,353**	**21,799**	**22,086**	**20,586**	**17,163**	**16,899**	**16,401**	**17,798**	**20,266**	**20,266**
325	**Chemical manufacturing**	**101**	**107**	**236**	**195**	**150**	**179**	**246**	**308**	**341**	**345**
3254	Pharmaceutical and medicine manufacturing	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**25**	**29**	**33**
3251-53, 3255-56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	**101**	**107**	**236**	**195**	**150**	**179**	**246**	**283**	**312**	**312**
334	**Computer and electronic product manufacturing**	**4,125**	**4,290**	**6,337**	**5,993**	**5,544**	**5,847**	**5,470**	**6,507**	**7,557**	**7,606**
3341	Computer and peripheral equipment manufacturing	**336**	**260**	**4**	**0**	**0**	**13**	**25**	**26**	**26**	**27**
3342	Communications equipment manufacturing	**194**	**179**	**518**	**206**	**433**	**298**	**215**	**266**	**173**	**221**
3344	Semiconductor and other electronic component manufacturing	**611**	**474**	**59**	**77**	**107**	**148**	**48**	**28**	**22**	**22**
3345	Navigational, measuring, electromedical, and control instruments manufacturing	**2,971**	**3,371**	**5,749**	**5,705**	**5,002**	**5,382**	**5,180**	**6,180**	**7,332**	**7,332**
3343, 3346	Other computer and electronic products manufacturing	**13**	**6**	**7**	**5**	**2**	**7**	**2**	**7**	**4**	**4**
336	**Transportation equipment manufacturing**	**10,649**	**10,852**	**8,870**	**8,338**	**5,533**	**4,961**	**4,692**	**5,990**	**7,259**	**7,249**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	**1,815**	**1,755**	**822**	**889**	**716**	**1,118**	**364**	**597**	**66**	**67**
3364	Aerospace product and parts manufacturing	**8,793**	**9,047**	**8,026**	**7,417**	**4,789**	**3,785**	**4,305**	**5,356**	**3,862**	**3,862**
3365-66, 3369	Other transportation equipment manufacturing	**42**	**50**	**22**	**32**	**28**	**58**	**23**	**37**	**3,331**	**3,320**
5112	**Software publishers**	**41**	**48**	**67**	**49**	**78**	**44**	**53**	**54**	**56**	**56**
5415	**Computer systems design and related services**	**143**	**177**	**231**	**228**	**226**	**498**	**1,589**	**419**	**235**	**378**
5417	**Scientific R&D services**	**1,873**	**2,130**	**2,416**	**2,870**	**2,936**	**3,351**	**2,299**	**1,886**	**2,006**	**1,972**
	All other for-profit industries	**4,422**	**4,195**	**3,929**	**2,913**	**2,695**	**2,019**	**2,052**	**2,634**	**2,812**	**2,660**

Source is the National Science Foundation Survey of Industrial R&D, various years
NAICS North American Industry Classification System
R&D Research and development
Notes: The 1987-96 data are converted/backcast and the 1997-2004 are the NSF reported data.
Data exclude the industry administered federally funded research and development centers (FFRDCs) for the period 1987-2004.
These data exclude the adjustment for consumption of fixed capital.

Appendix Table 2.1 R&D Expenditures in the United States: Total (Company & Other and Federally Funded), 1987-2004
(Millions of dollars, calendar year basis), Adjusted for the 2004 Reclassification and Consumption of Fixed Capital

NAICS code	Industry	1987	1988	1989	1990	1991	1992	1993	1994	1995
	All for-profit industries	**91,764**	**96,633**	**101,836**	**109,479**	**116,943**	**119,162**	**118,093**	**120,549**	**133,028**
325	**Chemical manufacturing**	**8,537**	**9,771**	**10,705**	**11,750**	**13,015**	**13,740**	**15,108**	**15,263**	**15,762**
3254	Pharmaceutical and medicine manufacturing	3,669	4,374	4,948	5,294	6,270	7,162	8,262	8,834	9,250
3251-53, 3255 56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	4,868	5,397	5,757	6,456	6,745	6,578	6,846	6,429	6,512
334	**Computer and electronic product manufacturing**	**17,907**	**17,451**	**17,227**	**18,417**	**19,838**	**20,570**	**18,883**	**21,577**	**25,936**
3341	Computer and peripheral equipment manufacturing	4,230	4,123	4,072	4,353	4,689	4,863	4,468	5,112	6,141
3342	Communications equipment manufacturing	1,512	1,473	1,452	1,553	1,672	1,732	1,586	1,804	2,174
3344	Semiconductor and other electronic component manufacturing	7,643	7,448	7,353	7,861	8,467	8,779	8,060	9,209	11,070
3345	Navigational, measuring, electromedical, and control instruments manufacturing	4,231	4,123	4,070	4,351	4,687	4,860	4,461	5,098	6,128
3343, 3346	Other computer and electronic products manufacturing	291	284	280	300	323	335	308	354	424
336	**Transportation equipment manufacturing**	**36,419**	**36,725**	**35,417**	**32,356**	**27,960**	**28,035**	**27,782**	**28,283**	**32,882**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	10,297	10,874	11,677	10,761	10,888	10,964	12,278	13,955	15,689
3364	Aerospace product and parts manufacturing	25,380	25,116	23,062	20,978	16,583	16,581	15,055	13,907	16,692
3365-66, 3369	Other transportation equipment manufacturing	742	735	678	616	490	490	449	420	501
5112	**Software publishers**	**827**	**1,145**	**1,365**	**1,751**	**2,309**	**2,443**	**3,087**	**3,227**	**3,694**
5415	**Computer systems design and related services**	**444**	**611**	**832**	**1,237**	**1,790**	**1,839**	**2,036**	**1,966**	**2,172**
5417	**Scientific R&D services**	**1,614**	**2,166**	**2,919**	**4,348**	**5,912**	**6,000**	**6,404**	**5,800**	**5,734**
	All other for-profit industries	**26,016**	**28,764**	**33,371**	**39,620**	**46,119**	**46,535**	**44,792**	**44,433**	**46,849**

NAICS code	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004
	All for-profit industries	**145,548**	**158,764**	**170,608**	**185,839**	***203,962***	***206,910***	***197,529***	***202,971***	**211,591**
325	**Chemical manufacturing**	**15,960**	**16,959**	**19,491**	**20,780**	***22,557***	***26,314***	***28,271***	***34,247***	**40,078**
3254	Pharmaceutical and medicine manufacturing	8,841	10,440	9,808	12,489	*13,725*	*14,855*	*19,455*	*25,848*	31,932
3251-53, 3255 56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	7,120	6,519	9,683	8,291	*8832*	*11459*	*8816*	*8400*	8,148
334	**Computer and electronic product manufacturing**	**30,240**	**35,068**	**39,389**	**38,454**	***48,652***	***52,672***	***50,131***	***49,695***	**49,291**
3341	Computer and peripheral equipment manufacturing	7,154	8,294	8,524	4,278	*5,318*	*3,338*	*4,080*	*3,426*	5,850
3342	Communications equipment manufacturing	2,541	2,949	9,014	7,467	*14,044*	*19,272*	*12,901*	*12,107*	8,827
3344	Semiconductor and other electronic component manufacturing	12,907	14,968	9,669	11,213	*13,411*	*15,424*	*15,945*	*16,887*	18,052
3345	Navigational, measuring, electromedical, and control instruments manufacturing	7,144	8,285	11,579	14,722	*15,549*	*13,512*	*16,602*	*16,529*	15,400
3343, 3346	Other computer and electronic products manufacturing	493	572	604	775	*330*	*1,125*	*602*	*747*	1,162
336	**Transportation equipment manufacturing**	**33,292**	**32,858**	**29,805**	**32,536**	***28,860***	***26,540***	***26,814***	***32,595***	**33,599**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	16,877	16,222	14,715	19,015	*19,335*	*17,668*	*16,158*	*18,233*	15,871
3364	Aerospace product and parts manufacturing	15,936	16,152	14,674	12,854	*8,770*	*7,963*	*9,696*	*13,249*	13,162
3365-66, 3369	Other transportation equipment manufacturing	479	484	416	667	*755*	*909*	*960*	*1,113*	4,566
5112	**Software publishers**	**6,423**	**7,347**	**9,389**	**11,083**	***12,861***	***13,566***	***13,830***	***16,475***	**16,839**
5415	**Computer systems design and related services**	**2,597**	**3,242**	**3,159**	**4,304**	***6,125***	***12,375***	***17,690***	***15,033***	**11,794**
5417	**Scientific R&D services**	**5,861**	**7,027**	**9,126**	**10,575**	***12,843***	***13,655***	***11,142***	***10,021***	**11,542**
	All other for-profit industries	**51,175**	**56,263**	**60,249**	**68,107**	***72,064***	***61,789***	***49,650***	***44,904***	**48,447**

Source is the National Science Foundation Survey of Industrial R&D, various years

NAICS North American Industry Classification System

R&D Research and development

Data exclude the industry administered federally funded research and development centers (FFRDCs) for the period 1987-2004.

Appendix Table 2.2 R&D Expenditures in the United States: Company Funded & Other, 1987-2004
(Millions of dollars, calendar year basis) Adjusted for the 2004 Reclassification and consumption of Fixed Capital

NAICS code	Industry	1987	1988	1989	1990	1991	1992	1993	1994	1995
	All for-profit industries	**62,496**	**67,895**	**74,957**	**83,178**	**92,372**	**96,331**	**96,767**	**99,742**	111,327
325	**Chemical manufacturing**	**8,482**	**9,707**	**10,635**	**11,673**	**12,930**	**13,650**	**15,010**	**15,163**	15,659
3254	Pharmaceutical and medicine manufacturing	3,669	4,374	4,948	5,294	6,270	7,162	8,262	8,834	9,250
3251-53, 3255 56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	4,813	5,333	5,687	6,380	6,660	6,488	6,747	6,329	6,409
334	**Computer and electronic product manufacturing**	**13,853**	**14,297**	**14,344**	**14,860**	**15,050**	**16,051**	**16,013**	**18,031**	22,316
3341	Computer and peripheral equipment manufacturing	3,623	3,739	3,753	3,888	3,938	4,201	4,194	4,729	5,849
3342	Communications equipment manufacturing	1,257	1,297	1,299	1,346	1,363	1,452	1,445	1,620	2,010
3344	Semiconductor and other electronic component manufacturing	6,546	6,755	6,777	7,021	7,111	7,584	7,566	8,519	10,544
3345	Navigational, measuring, electromedical, and control instruments manufacturing	2,173	2,243	2,250	2,331	2,361	2,518	2,512	2,828	3,501
3343, 3346	Other computer and electronic products manufacturing	255	263	264	274	277	296	296	334	413
336	**Transportation equipment manufacturing**	**15,519**	**15,913**	**16,471**	**15,933**	**16,568**	**18,441**	**18,447**	**19,453**	21,035
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	7,659	8,240	9,139	8,804	9,267	9,473	10,943	12,262	13,888
3364	Aerospace product and parts manufacturing	7,451	7,273	6,948	6,757	6,918	8,496	7,072	6,772	6,732
3365-66, 3369	Other transportation equipment manufacturing	409	400	384	373	384	472	432	419	414
5112	**Software publishers**	**712**	**1,001**	**1,226**	**1,673**	**2,239**	**2,351**	**2,982**	**3,109**	3,596
5415	**Computer systems design and related services**	**269**	**573**	**773**	**1,136**	**1,637**	**1,681**	**1,864**	**1,790**	1,982
5417	**Scientific R&D services**	**569**	**516**	**996**	**2,033**	**3,021**	**3,083**	**3,133**	**3,187**	3,402
	All other for-profit industries	**23,091**	**25,888**	**30,512**	**35,870**	**40,926**	**41,074**	**39,318**	**39,009**	43,338

NAICS code	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004
	All for-profit industries	**123,718**	**136,496**	**148,059**	**164,839**	***186,459***	***189,602***	***180,818***	***184,974***	**191,005**
325	**Chemical manufacturing**	**15,856**	**16,848**	**19,248**	**20,578**	***22,402***	***26,127***	***28,017***	***33,934***	**39,724**
3254	Pharmaceutical and medicine manufacturing	8,841	10,440	9,808	12,489	*13,725*	*14,855*	*19,455*	*25,822*	31,897
3251-53, 3255 56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	7,015	6,408	9,439	8,089	*8677*	*11273*	*8562*	*8112*	7,827
334	**Computer and electronic product manufacturing**	**25,981**	**30,644**	**32,869**	**32,303**	***42,937***	***46,596***	***44,579***	***43,136***	**41,590**
3341	Computer and peripheral equipment manufacturing	6,804	8,023	8,520	4,278	*5,318*	*3,325*	*4,055*	*3,399*	5,823
3342	Communications equipment manufacturing	2,346	2,769	8,494	7,259	*13,608*	*18,972*	*12,682*	*11,837*	8,601
3344	Semiconductor and other electronic component manufacturing	12,276	14,479	9,606	11,132	*13,299*	*15,266*	*15,896*	*16,858*	18,029
3345	Navigational, measuring, electromedical, and control instruments manufacturing	4,076	4,807	5,652	8,864	*10,383*	*7,915*	*11,346*	*10,302*	7,978
3343, 3346	Other computer and electronic products manufacturing	480	566	597	770	*328*	*1,118*	*600*	*740*	1,158
336	**Transportation equipment manufacturing**	**22,544**	**21,908**	**20,858**	**24,117**	***23,274***	***21,522***	***22,099***	***26,583***	**26,282**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	15,047	14,453	13,887	18,119	*18,614*	*16,540*	*15,790*	*17,632*	15,803
3364	Aerospace product and parts manufacturing	7,061	7,024	6,578	5,362	*3,934*	*4,133*	*5,372*	*7,875*	9,278
3365-66, 3369	Other transportation equipment manufacturing	435	431	393	635	*727*	*850*	*937*	*1,075*	1,201
5112	**Software publishers**	**6,382**	**7,298**	**9,321**	**11,033**	***12,782***	***13,521***	***13,776***	***16,420***	**16,783**
5415	**Computer systems design and related services**	**2,451**	**3,061**	**2,923**	**4,071**	***5,894***	***11,864***	***16,060***	***14,609***	**11,408**
5417	**Scientific R&D services**	**3,929**	**4,831**	**6,638**	**7,624**	***9,824***	***10,189***	***8,789***	***8,110***	**9,538**
	All other for-profit industries	**46,576**	**51,904**	**56,204**	**65,113**	***69,346***	***59,781***	***47,498***	***42,182***	**45,680**

Source is the National Science Foundation Survey of Industrial R&D, various years
NAICS North American Industry Classification System
R&D Research and development
Data exclude the industry administered federally funded research and development centers (FFRDCs) for the period 1987-2004.

Appendix Table 2.3 R&D Expenditures in the United States: Federally Funded, 1987-2004
(Millions of dollars, calendar year basis), Adjusted for Consumption of Fixed Capital

NAICS code	Industry	1987	1988	1989	1990	1991	1992	1993	1994	1995
	All for-profit industries	**29,269**	**28,739**	**26,880**	**26,300**	**24,572**	**22,830**	**21,326**	**20,806**	**21,701**
325	**Chemical manufacturing**	**56**	**64**	**70**	**77**	**85**	**90**	**99**	**100**	**103**
3254	Pharmaceutical and medicine manufacturing	0	0	0	0	0	0	0	0	0
3251-53, 3255 56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	56	64	70	77	85	90	99	100	103
334	**Computer and electronic product manufacturing**	**4,054**	**3,155**	**2,883**	**3,557**	**4,788**	**4,519**	**2,871**	**3,546**	**3,620**
3341	Computer and peripheral equipment manufacturing	607	384	319	465	751	662	274	383	292
3342	Communications equipment manufacturing	255	176	153	207	309	280	141	184	164
3344	Semiconductor and other electronic component manufacturing	1,097	693	575	840	1,356	1,196	494	690	526
3345	Navigational, measuring, electromedical, and control instruments manufacturing	2,058	1,880	1,820	2,020	2,326	2,342	1,950	2,269	2,627
3343, 3346	Other computer and electronic products manufacturing	36	21	16	26	46	39	12	19	11
336	**Transportation equipment manufacturing**	**20,900**	**20,812**	**18,946**	**16,423**	**11,391**	**9,594**	**9,334**	**8,829**	**11,847**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	2,638	2,634	2,538	1,957	1,621	1,490	1,334	1,693	1,801
3364	Aerospace product and parts manufacturing	17,929	17,843	16,114	14,222	9,664	8,085	7,983	7,136	9,959
3365-66, 3369	Other transportation equipment manufacturing	333	335	294	243	106	18	17	1	87
5112	**Software publishers**	**115**	**144**	**139**	**77**	**70**	**91**	**105**	**118**	**98**
5415	**Computer systems design and related services**	**175**	**38**	**59**	**101**	**154**	**158**	**171**	**176**	**190**
5417	**Scientific R&D services**	**1,044**	**1,651**	**1,923**	**2,315**	**2,891**	**2,917**	**3,271**	**2,613**	**2,332**
	All other for-profit industries	**2,926**	**2,876**	**2,860**	**3,750**	**5,193**	**5,461**	**5,475**	**5,424**	**3,511**

NAICS code	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004
	All for-profit industries	**21,830**	**22,269**	**22,549**	**20,999**	**17,502**	**17,308**	**16,711**	**17,997**	**20,586**
325	**Chemical manufacturing**	**104**	**111**	**244**	**202**	**155**	**186**	**254**	**313**	**354**
3254	Pharmaceutical and medicine manufacturing	0	0	0	0	0	0	0	25	33
3251-53, 3255 56, 3259	Chemicals minus pharmaceutical and medicine manufacturing	104	111	244	202	155	186	254	288	321
334	**Computer and electronic product manufacturing**	**4,258**	**4,424**	**6,521**	**6,151**	**5,715**	**6,075**	**5,552**	**6,559**	**7,701**
3341	Computer and peripheral equipment manufacturing	350	271	4	0	0	13	26	26	28
3342	Communications equipment manufacturing	195	180	520	207	436	300	219	270	226
3344	Semiconductor and other electronic component manufacturing	631	489	62	81	112	158	49	29	22
3345	Navigational, measuring, electromedical, and control instruments manufacturing	3,069	3,478	5,927	5,858	5,165	5,597	5,256	6,227	7,422
3343, 3346	Other computer and electronic products manufacturing	14	6	7	5	2	7	2	7	4
336	**Transportation equipment manufacturing**	**10,748**	**10,949**	**8,948**	**8,419**	**5,586**	**5,018**	**4,715**	**6,013**	**7,317**
3361-63	Motor vehicles, bodies and trailers, and parts manufacturing	1,830	1,768	828	895	721	1,128	368	601	68
3364	Aerospace product and parts manufacturing	8,874	9,128	8,096	7,491	4,837	3,831	4,324	5,374	3,885
3365-66, 3369	Other transportation equipment manufacturing	44	53	23	32	28	59	23	37	3,365
5112	**Software publishers**	**42**	**49**	**68**	**50**	**79**	**45**	**54**	**55**	**57**
5415	**Computer systems design and related services**	**146**	**181**	**236**	**233**	**231**	**510**	**1,630**	**424**	**385**
5417	**Scientific R&D services**	**1,932**	**2,195**	**2,488**	**2,951**	**3,019**	**3,466**	**2,354**	**1,911**	**2,005**
	All other for-profit industries	**4,599**	**4,359**	**4,045**	**2,994**	**2,717**	**2,008**	**2,152**	**2,722**	**2,767**

Source is the National Science Foundation Survey of Industrial R&D, various years

NAICS North American Industry Classification System

R&D Research and development

Data exclude the industry administered federally funded research and development centers (FFRDCs) for the period 1987-2004.