R&D Expenditures for the U.S.
A Frascati to System of National Accounts Application to U.S. Data

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Abstract:

This paper translates research and development expenditure data organized based on the *Frascati Manual* for the U.S. to a measure of gross output consistent with *The System of National Accounts 1993*. A set of detailed tables translates U.S. survey data on the performance of R&D from the National Science Foundation for 2001.

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1. Introduction

The practical task of capitalizing Research and Development (R&D) expenditures for each country involves a translation of existing data into a form appropriate for economic measurement. A general framework for translating Frascati-based expenditures into gross output consistent with the System of National Accounts (*SNA*) is described in Robbins (2006). This paper and the accompanying tables apply that general framework to R&D survey data compiled by the National Science Foundation (NSF) for the U.S.

The paper is organized in the following way. Section 1 provides two summary tables that illustrate the framework that will be used to translate R&D expenditures into a measure of gross output. Section 2 describes the step by step translation of NSF-compiled survey data into a measure of gross output, net exports, and gross capital formation for each sector. Section 3 concludes with an evaluation of the NSF data for this task, and recommendations. Tables C, D, and Tables 1 – 11 detail the translation for 2001. Commonly used acronyms are listed at the end of the paper before the references.

1.1. Summary of the Frascati-to SNA Adjustments

This section summarizes the adjustments required to move from Frascati expenditures to *SNA*-based gross output. NSF data are collected to be consistent with the *Frascati Manual (FM)*; translating the data into an *SNA* framework involves adjusting the classification of the sectors of the economy and reorganizing the expenditure data into

three parts: gross output, net exports and imports, and gross additions to capital formation.

Table A Linking Frascati Sectors to *SNA* Sectors

	OECD *Frascati Manual*	*SNA*	BEA's Frascati-SNA Link
1.	Business Enterprise Sector	Non-financial corporations (Table 1)	Non-financial corporations (Table 1)
		Financial Corporations (Table 2)	Financial Corporations (Table 2)
2.	Government Sector	General Government (Table 3)	Federal Government (Table 4)
			Federally Funded R&D Centers (Table 5)
			State and Local Government (Table 7)
3.	Private Non-Profit Sector	Non-profit Institutions Serving Households (Table 8)	Non-profit Institutions Serving Households (Table 9)
		Households (no survey data)	
4.	Higher Education Sector	General Government (Table 3)	Public Colleges and Universities (Table 6)
		Non-profit Institutions Serving Households (Table 8)	Private Colleges and Universities (Table 10)
5.	Abroad	Rest Of World (Table 11)	Rest of World (Table 11)

Table A illustrates the linking of sectors from *FM* (Column 1) to *SNA* sectors (Column 2), and to the tables in this paper that detail the translation (Column 3). The table layout of the link corresponds to the structure of the source data. In some cases, data from one survey were disaggregated to create separate sectors, for example NSF data on industrial R&D were disaggregated by industry to create a non-financial corporate sector and a financial corporate sector. In other cases data from multiple surveys were combined to develop sector estimates. The general government sector is the aggregation of data from the federal government, federally funded R&D centers (FFRDCs), state and local government, and public colleges and universities. A complete discussion on the

sectoring framework is provided in Robbins (2006). Table B summarizes the adjustments made to convert expenditures to output.

Table B. Frascati to *SNA* Adjustments

		Explanation of Adjustment
I. Output		
Frascati-Based Intramural Expenditures on R&D for each sector This includes current costs (labor, materials, supplies, and equipment) and capital expenditures.		
Plus expenditures for R&D as defined by *SNA* but excluded from Frascati-defined R&D	+/-	The scope of R&D in the *SNA* is not precisely defined and can be interpreted differently from that of the *FM*. The *SNA* could be interpreted to include spending that leads to new or improved products or processes without explicit novelty. It can also be interpreted to exclude basic research that is not directed toward product or process improvement.
Plus R&D purchased as an intermediate input to production of R&D in the sector	+	*SNA*-based gross output includes intermediate consumption, including the cost of any purchased R&D. Frascati-based output is reported either by performer or by funder and excludes intermediate consumption to avoid double-counting.
Plus any drawing down of inventories or supplies	+	*SNA*-based gross output reflects the value of inputs used in the production process, while the Frascati-based measure includes all expenditures for R&D. This is likely a small amount, no adjustment is recommended.
		Remove any additions to gross capital
Subtract capital expenditures for structures, equipment, and software	-	Frascati-based reporting calls for separate accounting for capital expenditures; these are land and buildings, equipment and purchased software. All of these expenditures should be removed from an *SNA*-based measure of gross output.
Subtract additions to inventories or supplies	-	Expenditures for materials and supplies not used for R&D production in the current period are not part of the value of output.
		Adjustments to move from expenditures to full value of output
Plus consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D performed in the US.	+	The *SNA* includes consumption of fixed capital as part of the cost of production; Frascati-based expenditures do not include depreciation or CFC measures.
Plus other taxes on production less subsidies	+	Some taxes on labor are included in Frascati-based expenditures, others may be missing.
Plus Net Operating Surplus	+	The cost of capital includes both the consumption of fixed assets plus the opportunity cost of holding fixed assets. For market producers the latter component could be proxied with net operating surplus or markup. No net operating surplus is included for the output for non-market producers.
Gross Output		

Table B. Frascati to *SNA* Adjustments (Continued)

II. Exports and Imports of R&D Output		
Exports	+	Exports are sales, barter, gifts or grants of R&D services from resident to non-resident units.
Imports	-	Imports are sales, barter, gifts or grants of R&D services from non-resident units to resident units.
Net Exports		
III. Gross Capital Formation		
		Fixed Investment
Investment in structures	+	This measure should exclude land.
Investment in Equipment	+	This should be equipment with a useful life of a year or more.
Investment in Software	+	This should be software with a useful life of a year or more.
Net disposals of capital goods	-	This should be sales or purchases of used assets.
Fixed Investment Subtotal		
Investment in inventories	+	This refers to inventories of materials used for R&D.
Gross Capital Formation		

The application of these adjustments to actual source data as compiled by the NSF for the U.S. submission to OECD is described in the section of the paper that follows and detailed in Tables 1-11 that accompany this paper. Summary Table C of the Link tables presents R&D expenditures in three components, gross output, net exports, and net additions to capital. The total for gross output of R&D services, $285.9 billion, is the Frascati-based, NSF-measured expenditures plus the approximate adjustments made to translate these expenditures to be consistent with the *SNA*. The export value ($4.3 billion) is based on limited source data and covers trade in Research, Development and Testing Services and some funding of foreign R&D by the federal government. The scope of these Research, Development, and Testing Services are broader than the

Frascati-based definition of R&D. The third section of Table C, Net Additions to Capital, estimates the expenditures for capital used to produce R&D, $12.5 billion.

Summary Table D of the Link Tables reconciles Frascati-based expenditures for 2001 with the translation to gross output. The columns in Row I are the initial Frascati-based expenditures rearranged into *SNA* sectors. The Row I total in the far right column of Table D is the Frascati-based U.S. expenditure for R&D that comes from the NSF's U.S. data submission. Table D indicates that the adjustments to align the scope of the U.S. survey data with that of the Frascati/*SNA* framework add $1.1 billion. Intermediate inputs add $6.2 billion. Basic adjustments for embedded capital expenditures remove $3.1 billion; with the exception of the federal government, this does not include any adjustment for embedded software. The adjustment for consumption of fixed capital adds $6.4 billion in Row V. A small adjustment of $647 million represents R&D performed by state and local governments.

2. Description of Sector by Sector Concordance Issues

The translation tables each have three parts. Part 1 provides a translation of *FM* expenditures to gross output for each sector. Part 2 tallies R&D transactions between resident and non-resident units as imports and exports. Part 3 breaks out the changes in gross fixed capital formation and inventory. The starting place for each sector's estimate is the Frascati-based expenditure for the performance of R&D in calendar year 2001. In each case where survey data are available for the adjustment, the adjustment amount is provided in the column. Missing components that are very large or necessary for the CFC imputation are estimated and noted with italics. Where the magnitude of the adjustment cannot be reasonably estimated, it is left blank.

2.1. National Science Foundation Survey Data

The National Science Foundation's Division of Science Resources Statistics coordinates the collection and reporting of survey data on R&D expenditures and consolidates these data in the publication, National Patterns of Research and Development Resources (NSF 2003a). These surveys provide the basis for the U.S. component of the OECD data on expenditures by performers and expenditures by funders. Two annual surveys published by the NSF provide direct detailed information on R&D expenditures. These are the Survey of Industrial R&D (SIRD or RD-1) and the Survey of Research and Development Expenditures at Universities and Colleges (NSF 411). An abbreviated version of the NSF 411 survey is collected annually for federally funded research and development centers. Two additional annual surveys provide information on outlays and obligations by the federal government for R&D. These are the Survey of Federal Funds for R&D and the Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions. The Scientific and Engineering Research Facilities Survey provides information on construction plans and capital spending and is conducted biennially. An NSF sponsored Gallup survey, Research and Development Funding and Performance by Nonprofit Organizations was last conducted in fiscal 1996 and 1997 and has been discontinued. The Survey of State Research and Development expenditures was conducted in 1977, 1988, and 1995.

The translation tables accompanying this paper are laid out to illustrate the use of the survey data to account for R&D on an *SNA* basis, and the tables indicate where no survey

data are available for the component of estimate. While most of the adjustments in the tables are to align the Frascati-based expenditures with SNA-based output, some of the adjustments align the NSF-compiled survey data with the scope suggested by *FM*. Frascati-based measures should separately tabulate capital costs, and exclude depreciation (consumption of fixed capital) from current costs. The NSF-collected data that form the U.S. submission to OECD for the Frascati-based R&D expenditures are not consistently disaggregated into the Frascati recommended subcategories of labor costs, other current costs, and capital breakdown of structures, equipment and software. For the industrial, academic, and non-profit surveys, capital expenditures are explicitly excluded and a historical cost depreciation measure is included as part of indirect cost.

Because of the importance of consumption of fixed capital (CFC) in estimating gross output, approximations are made in these tables for both investment and CFC. First, an estimate is made of capital investment for each sector. Capital investment for R&D in each sector for 1) equipment and software and 2) structures are both assumed to be made in the same ratio to gross output as in the R&D services industry, NAICS 5417. These two ratios, equipment and software to output and structures to output, are created from the 1997 BEA capital flow table and the 1997 BEA benchmark Input-Output table. A proxy for CFC is developed from the ratio of CFC to investment. This is estimated for 2001 for equipment and software and for nonresidential investment from NIPA investment data. This is done for private investment and applied to market R&D and for general government and applied to nonmarket R&D.

2.2. Business Sector

The tables accompanying this paper link the Frascati-based business sector to two *SNA*-based sectors; these are nonfinancial corporations (Table 1) and financial corporations (Table 2). Each table starts with R&D performed in the business sector. The Frascati-based measure of expenditures aggregated by the NSF, Business Expenditures for R&D, is the sum of industry performed R&D and R&D performed at industry-administered federally funded research and development centers (FFRDCs).[1] Since FFRDCs are included in the government sector in the SNA-linked tables in this paper, the starting point for the business sector expenditure total is the Frascati-based total minus expenditures at industry-administered FFRDCs.

Since *SNA* sectors are divided into non-financial and financial corporations, the business sector data must be allocated into these broad industry classes to create separate tables. Thus R&D for financial corporations is subtracted from Table 1, and R&D for non-financial corporations is subtracted from Table 2. The source data for Industry R&D come from the Survey of Industry Research and Development (the RD-1 survey) a Census administered, company-based survey whose target universe is all for-profit, nonfarm industrial companies that perform R&D. Industrial classification for a company is based on the industry classification of the activity within the company with the highest dollar value of payroll (NSF (2003b) pg. 121).[2] While the published data from the NSF do not provide a breakdown between financial and non-financial corporations, since the underlying data are coded by NAICS industries, the financial corporations can be

[1] In the near future, NSF will be including FFRDC data as part of the government sector.
[2] On a NAICS basis, farm industries are the three-digit industries 111, Crop Production, and 112, Animal Production. Crop production establishments primarily grow crops, plants, vines, trees, and their seeds. Animal production establishments raise or fatten animals for the sale of animals or animal products (Executive Office of the President, 2002).

separated out and aggregated. The Financial sector is identified by those enterprises whose principle activity is classified in International Standard Industrial Classification of all Economic Activities (ISIC) divisions 65, 66, and 67 (CEC et al., (1993) par. 4.79). This is the equivalent of NAICS sector 52, Finance and Insurance.

Two entries follow in the table that reflect the gap between survey coverage of enterprises and the theoretical *SNA* measure, rather than the gap between the Frascati-values and the SNA measure. The first is for survey coverage of the scope of reported R&D. On a Frascati basis, it should cover R&D in the social sciences and humanities (OECD (2002) par. 222). The RD-1 survey collects data on R&D in fields of science and engineering but not for social science and humanities.[3] No estimate is available for this.

The following section is included for discussion purposes and does not reflect an adjustment line on the tables. While no adjustment is recommended, R&D expenditures in industries categorized in the agriculture sector are also excluded from the data. The RD-1 survey excludes R&D firms classified by NAICS in the agricultural sector, and the magnitude of their expenditure is believed to be very small. An analysis of Census microdata found that agribusiness firms performing R&D tend to be classified in the food, beverage, and chemical manufacturing industries rather than in agriculture.[4] While the current magnitude of the missed expenditures is unknown, the total reported in the NSF's survey of industrial R&D for agricultural services in 1997 was $7 million dollars or about .0045% of industry-performed R&D for that year (NSF (2000)).

[3] The NSF provides two reasons for this coverage; first, they argue that respondents' inexperience with these data would render the data not comparable with that collected in other sectors. Second, NSF argues that industry-performed R&D in the social sciences is focused primarily on firm internal decision making about existing processes and products and is not focused on new products and processes (NSF 2001a).
[4] As described by Brandon Shackelford of NSF.

Line 5 of Table 1 aligns the survey data with *FM* by adding in the R&D expenditures of non-profit institutions that serve the business sector. In both an *FM* and an *SNA* framework, these expenditures should be included in the business sector. These types of non-profits were identified based on categories used on the last NSF sponsored Gallup survey, Research and Development Funding and Performance by Nonprofit Organizations, as trade associations and industry consortiums. The largest of these performers in 1997, the last fiscal year with individual data, is SEMATECH, Inc., a consortium of semiconductor manufacturers, with expenditures of $97 million in 1997 (NSF (2001b), Table A-11). While ideally these institutions should be assigned to either the financial or non-financial sector, depending on the sector of the businesses whose interests they are designed to promote, in this link they are assigned to the non-financial corporations sector.

The adjustment for R&D used as an intermediate input to production of other R&D is made based on a question about purchased R&D on the RD-1 survey. This question specifically asks for the cost of R&D performed by others for the company, and divides it into for profit companies, universities or colleges, and other non-profit organizations. It excludes R&D performed for the company outside of the U.S.

The next section of Tables 1 and 2 allows for the identification of capital expenditures that may be embedded in the survey data. The RD-1 survey specifically excludes capital spending, so any inclusions would be the result of differing definitions of capital expenditures between the survey respondents and an SNA accounting. While the *FM* calls for separate expenditure measures for structures, equipment, and software, complete separation is an accounting challenge for survey respondents. To the extent that

research equipment and software purchases are included in the Frascati-based current expenditures, they should be removed and reassigned to gross capital formation, Section III of the table.

It has not been possible to determine the extent of software spending in the Frascati-based numbers for the U.S. for this link. Because of the uncertainty surrounding the magnitude of these embedded costs, no subtraction of these embedded software costs is currently included in the translation tables. The following section discusses the issues involved in identifying these embedded software costs.

Instructions for the RD-1 form tell respondents to include the cost of computer software used in R&D activities and exclude capital expenditures (NSF and U.S. Department of Commerce (2002)). While the RD-1 form does identify expenditures for the creation of software produced for sale to others, neither the RD-1 nor other NSF surveys separately identify the expenditures for the purchase of software. Since the RD-1 form tells respondents to exclude capital expenditures, firms that capitalize or amortize their expenditures on software for tax purposes can reasonably be assumed to have excluded these expenditures from their reported R&D performed. However, the share of total business purchase of software that is capitalized for tax purposes is currently not known with any certainty.[5]

[5] Both accounting standards and tax regulations provide room for firms to either expense or capitalize the software expenditures associated with R&D activities, depending on the future use of the software. Accounting standards call for software with a useful life of more than a year to be capitalized. Those without future uses should be expensed, and those with future uses should be amortized (FASB (1974) par 11). This directive is interpreted to include software created inhouse FASB (1975 par 6 – 8). The costs of developing software for sale are considered to be R&D expenses until technical feasibility is determined. Thereafter development costs are to be capitalized (FASB (1985) par 3). According to the IRS, purchases of software and the creation of own account software can be treated either as capital investment or as a current expense, as long as the firm's treatment of software is consistent (IRS (2000) as modified by Revenue Procedure 2004-11, Internal Revenue Bulletin 2004-3, January 20, 2004). Since the IRS permits

For all industries, current BEA methodology assumes that only a small percentage of software actually is capitalized in Internal Revenue Service (IRS) returns. BEA currently assumes that 80% of prepackaged and custom software is not reported as investment to the IRS, and that 97% of own-account software is not reported to the IRS as investment. Recently released data from the Census for 2003 from the Information and Communication Technology (ICT) Survey, a component of the Annual Capital Expenditure Survey (ACES), provide new information on capitalized and expensed purchases of software. This survey reveals that the magnitude of expensed (non-capitalized) software and information and communication equipment spending is nearly as large as the capitalized component of this spending. Companies with employees spent $33.1 billion in non-capitalized expenditures for development and purchases of computer software excluding licensing and maintenance agreements, and $44.3 billion in capitalized expenditures for purchase and development of computer software. For NAICS industry 54, Professional, Scientific, and Technical services, non-capitalized expenditures for the broader category, information and communication equipment[6] was $13.0 billion, compared to $11.4 billion for capitalized expenditures for information and communication equipment. Thus, for the industry category that most closely matches R&D activity, more information and communication equipment expenditures were expensed than were capitalized.

While these data are broader in industry scope than solely the firms that report on the RD-1 form, they provide a good indication of the magnitude of non-capitalized

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items that would otherwise be capitalized but have a value under a certain threshold to be expensed, Grimm, et. al (2003) suggest that a large share of software falls below this threshold and is expensed.

[6] Computers and peripheral equipment, information and communication technology equipment excluding computers, electro-medical and electrotherapeutic apparatus, non-capitalized purchases and payroll for developing software, and non-capitalized software licensing and service agreements.

software and equipment relative to capitalized software and equipment across industries. Assuming that non-capitalized software and equipment expenditures are included in the RD-1 expenditure totals and capitalized expenditures are excluded from the RD-1 totals, the new data suggests that R&D expenditures reported on NSF-Census form RD-1 contain expenditures for software and other equipment that BEA would consider capital assets. In its accounting of consumption of fixed capital for software, BEA adjusts IRS-reported depreciation of software to account for this underreporting. To get an idea of the size of the adjustment made by BEA for the NIPA-based corporate sector, IRS-reported depreciation and amortization was $761.8 billion in 2001, and BEA added $113.9 billion for depreciation of software not reported in the IRS numbers. As noted earlier, no adjustment is made to the tables in the corporate sector for embedded software purchases, but improved survey questions on purchased software and expensed equipment would be useful in resolving this uncertainty.

Four final adjustments in Tables 1 and 2 are needed to reflect the value of gross output. Two steps adjust to add a current cost measure of consumption of fixed capital (CFC). CFC is a production cost that must be accounted for in an SNA-based accounting of output. The RD-1 form includes an estimate of depreciation at historical cost and this estimate could be scaled to current costs.[7] However, for consistency, a similar method is used in Tables 1 and 2 that is used for all the missing CFC measures in these link tables. The value of CFC is approximated from BEA data from the Input Output Tables, the

[7] In the SNA, this consumption of fixed capital (CFC) is the decline in the value of the fixed assets value of the fixed assets owned by an enterprise, as a result of their physical deterioration and normal rates of obsolescence and accidental damage. The value of a fixed asset is determined by the benefits that can be expected to flow from the asset for the remainder of its service life. This value is estimate in current period prices as a discounted value that would accrue to the owner of the fixed asset if it were to be rented out at current prices for the remainder of its service life (CEC, 1994 par 10.118). This measure of CFC differs from IRS-reported depreciation, because CFC is based on current replacement cost of the assets and IRS-reported depreciation is based on historical costs.

Capital Flow tables and NIPA data.[8] Since the RD-1 expenditures include this historical cost depreciation, it must be subtracted to avoid double-counting with the BEA-based CFC estimate.

The estimate of full value of output includes other taxes on production less subsidies, which must be added to the expenditure. While the RD-1 survey specifically excludes the value of tax credits and does not consider subsidies, no missing production taxes or subsidies have been identified.[9]

A final entry in the table is the addition of a net operating surplus for market producers. As discussed in Robbins (2006), the SNA can be understood to recommend two different methods for valuing the output of own account production for market producers.[10] Including a proxy for net operating surplus insures that the value of own account output takes into account the full cost of the fixed capital used to produce the R&D. Current NIPA methodology values own account output as the sum of the costs of production, without the additional cost component proxied with net operating surplus.

[8] First, an estimate is made of capital investment for sector. Capital investment for R&D in each sector for 1) equipment and software and 2) structures are both assumed to be made in the same ratio to gross output as in the R&D services industry, NAICS 5417. These two ratios, equipment and software to output and structures to output, are created from the 1997 BEA capital flow table and the 1997 BEA benchmark Input-Output table (BEA (2002) and BEA (2003)). The ratio of CFC to investment is estimated for 2001 for equipment and software and for nonresidential investment from NIPA investment data. This is done for private investment and applied to market R&D and for general government and applied to non-market R&D.

[9] While the U.S. federal tax code provides an R&D tax credit to firms with a 2001 value of $6,353 million, this tax credit is considered an adjustment to income taxes rather than a production subsidy. This is because they are only payable when the firm is profitable and thus has a tax liability, instead of being payable solely as consequence of production. Corporate income taxes are paid out of the net operating surplus but are not a cost of production. For a SNA discussion on other taxes on production, see CEC et al., (1993) par. 7.70. The characterization of tax credits as an adjustment to income taxes is not directly addressed in the SNA and follows current BEA interpretation.

[10] The general valuation rules of the SNA call for market and own-account goods and services to include a mark-up that reflects the net operating surplus or mixed income attributable to the producer (1993 SNA paragraph 3.73). However, to value own-account output, the SNA elsewhere suggests that production costs may need to be used instead when reliable market prices are not available. This "second best procedure" is to value output of the goods or services produced for own account as the sum of their costs in production, specifically intermediate consumption plus compensation of employees plus consumption of fixed capital plus other taxes less subsidies on production (CEC et al., (1993) par. 6.86).

Only partial information is available on exports and imports of R&D for the corporate sectors. The RD-1 survey asks firms to report their costs for R&D performed outside of the United States, but this question does not allow a inference to be made about whether the R&D service is used in the U.S. or overseas. Funding of R&D conducted in another country is not equivalent to an import of R&D services. The available information for the accounting of exports and imports in Section II of the nonfinancial corporate sector table is based on BEA data on trade in R&D services from BEA's International Services Transactions surveys. All of the trade in R&D services from this survey is allocated to the nonfinancial corporate sector, shown in part II of Table 1 because an industry analysis of the trade between multinationals and their affiliates revealed that the share of trade in R&D services attributed to firms in the financial sector is negligible. However, publicly available data do not allow the smaller component of the trade in R&D services, unaffiliated trade, to be disaggregated by industry. This component is assumed to be also in the non-financial corporate sector.

Section III of the tables for the financial and non-financial corporations sectors provides a framework to account for additions to gross fixed investment. As previously discussed, the Frascati framework calls for expenditures for structures, equipment, and software to be separately classified. An accurate accounting of the capital spending for R&D activity would be valuable for understanding the R&D production process its overall impact on economic output. While the RD-1 data do not provide questions on expenditures for structures, equipment, and software, an estimate was made in order to create a proxy for consumption of fixed capital. These were created based on the ratio of investment to gross output for NAICS industry 5417, R&D services.

Use of this ratio assumes that industrial R&D is similar in its input structure to the R&D Services industry, NAICS 5417. Since this ratio is created based on establishment data, it provides a good average measure of the capital to output ratio of private sector R&D labs. While no better proxy exists, the amount and types of capital inputs used for R&D is likely to vary substantially across performing industries. Improved survey data on capital inputs for R&D would allow better industry-level estimates to be made.

A complete accounting of additions to gross capital formation would include net disposals of used capital and net investment in inventories. These components of capital formation are considered to be relatively small.

2.3. Government

The government sector is composed of the R&D performed by 1) agencies of the federal government, 2) federally funded research and development centers (FFRDCs), 3) public colleges and universities, and 4) state and local governments. Tables 4 through 7 detail the links for each of these four subcomponents, and Table 3 aggregates them. While annual NSF survey data are available based on performance for the agencies of the federal government, for colleges and universities, as well as for FFRDCs, the data for FFRDCs are currently limited in the detail provided and there is currently no annual NSF survey for R&D performed by state and local governments.

2.3.1. Federal Government Performed R&D

Table 4 starts with intramural expenditures for U. S. federal-government-performed R&D as reported on a Frascati basis. These expenditures are subdivided into

labor costs, other current costs and total capital expenditures. The Frascati-based numbers differ from those reported in NSF's Table B1 of National Patterns of R&D Expenditures (NSF 2003a) in that the National Patterns numbers do not include a capital expenditure measure. This capital expenditure sum comes from a transformation of reported obligations into performance for the relevant fiscal years (2000 and 2001).

The value on line 2 reflects an imprecise adjustment for purchased R&D. The NSF's annual Survey of Federal Funds for R&D provides information on obligations and outlays of the federal government for R&D for fiscal years, which run from October 1 to September 30. Obligations are orders placed, contracts awarded, services rendered and similar transactions. Outlays are the actual checks and cash payments made during a given period (NSF (2004b)). These costs are reported as full coverage, which includes planning, administration, and overhead. The survey data do not provide a means to identify intermediate purchases of R&D. These are estimated using federally funded performance of R&D in industry 5417 from NSF's Science and Engineering Indicators (NSF (2004a)), which are derived from its RD-1 survey. The use of the estimator assumes that all of the federally funded performance in this industry is an intermediate input into the government's production of R&D, rather than a transfer or grant for R&D performance. The *FM* recommendation that two categories of government funding (procurement and transfers) be identified for R&D performed in the business sector and in the academic sector would be useful to characterize these transactions.[11]

Lines 5 through 7 of Table 4 reflect adjustments for capital expenditures embedded in the survey data. Data are reported for federal R&D plant, which includes

[11] These recommended categories are "those that are specifically for the procurement of R&D," and "those that are provided to the performers of R&D in the form of grants or other financial incentives, with the results of the R&D becoming the property of the R&D performers (OECD (2002) par. 396 through 398)."

R&D facilities and fixed equipment. This includes land but excludes mobile equipment, and thus is not an accurate measure of *SNA*-based capital assets. To transform these expenditures from a Frascati basis to gross output on an *SNA* basis, capital expenditures must be first subtracted from current expenditures. While the totals for R&D plant and fixed equipment can be readily backed out of obligations data, adjustments need to be made for other capital, like test equipment in the laboratory, office furniture, computers, and software. No survey data are available to estimate the amount of current expenditures that are devoted to this test equipment and software. Unlike uncertainty surrounding the extent of software expenditures embedded in the RD-1 data, there is little doubt that the federal performance numbers include this type of capital. The estimate used in the translation tables is based on equipment and software for NAICS 5417. The operating assumption for the use of this proxy is that the R&D activity done in federal labs is reasonably similar in its capital inputs to that of the R&D services industry (NAICS 5417).

The adjustments to move to the full value of output in lines 8 through 11 of Table 4 are simpler than the corresponding calculations for business R&D because no depreciation costs are assumed to be included in the federal data. In order to estimate CFC, a proxy for investment in equipment and software investment is created. The estimate for equipment and software investment is made assuming the same investment to gross output ratio as in the R&D services industry as described in Section 2.1. For the survey-reported expenditures on plant and equipment, the CFC ratio to investment for general government nonresidential structures in the NIPAS is used.

Since government–performed R&D is considered non-market output by definition in this set of translations tables, no adjustment is needed for net operating surplus. While this exclusion may undervalue output since interest and some rents are paid out of net operating surplus, it is consistent with the current *SNA.*[12]

Section II of the table reports exports and imports. In the absence of better measures of imports and exports of R&D services, obligations for foreign performers are used for imports of R&D services for the Federal Government. For imports this measure excludes payments made directly to U.S. government agencies, organizations or citizens performing R&D abroad for the Federal Government (NSF (2004b), Technical Notes page 8). This data limitation leads to an undercount for this component of imports of unknown magnitude. No data are available to estimate whether the federal government sells any R&D services to non-resident entities (exports).

2.3.2. Federally Funded Research and Development Centers (FFRDCs)

FFRDCs are owned or otherwise controlled and financed by the U.S. Federal government and administered under contracts between the U.S. government and institutions in industry, academia, and the non-profit sector.[13] For this linking, they are sectored in the general government sector regardless of who administers them. As discussed in Robbins (2006), this assignment is both consistent with the *SNA* and

[12] Including the full value of output of government in the national accounts is a topic of current discussion for the revision of the SNA, and some alternate representation of the value of capital services outside of the core accounts may well be recommended in the future.

[13] FFRDCs are institutions whose primary activity includes basic research, applied research, development, or management of R&D. They are separate organizational units from their parent institution and they perform their activities under direct monitorship from the federal government and receive major support from the federal government. They have a long-term relationship with the sponsoring agency of the federal government and most or all of the facilities are owned or funded for in the contract with the federal government (Burke (1999)).

supported by data from a mini-survey about R&D expenditures collected by the NSF. The expenditures for these centers are estimated in Table 5, and then aggregated with components of government R&D in Table 3. In practice, the NIPAs include FFRDCs with the sector that administers them.

The U.S. source data since fiscal year 2001 for the FFRDCs come from an abbreviated version of the NSF's academic R&D survey. This form provides very little detail for the adjustments necessary for the Frascati-to-*SNA* link. The adjustments for which there are insufficient survey data include the adjustment for acquired intermediate R&D, the adjustments for purchased software and any research equipment embedded in current expenditures. An adjustment for consumption of fixed capital is necessary even though the indirect costs asked for on the survey form conceptually include depreciation. This is because the latter is historical cost based rather than current cost based, as called for in an SNA-based measure.[14]

Accounting for imports for the FFRDCs involves identifying expenditures that are either made outside of the U.S. or are payment for services provided by vendors based outside the U.S. Accounting for exports involves identifying expenditures for R&D at FFRDCs that are funded by sources outside of the U.S. The NSF 411 form does not provide an entry to separately identify foreign sources of funding, though it does have an entry for "all other" after articulating government, industry, and institutionally financed research. Foreign funding would be a component of this.[15]

[14] IRS-reported depreciation is based on historical costs while CFC is based on current replacement cost of the assets.

[15] One FFRDC that this is particularly relevant for is the Aerospace Corporation, because federal funds accounted for only 32% of its funding in 2001 (NSF 2003a) and the center performs work for international organizations, and other governments when such work is deemed to be in the national interest. In terms of payments to foreigners, the National Astronomy and Ionosphere Center is located in Arecibo Puerto Rico and expenditures there should be counted as payments to non-resident institutions.

Finally, limited information is available to create an accumulation account for gross capital formation for the FFRDCs. Of the five components of gross capital formation -- structures, equipment, software, inventories, and net disposals of capital goods -- the first three components would be most important to capture. The federal funds data provide obligations for R&D plant that are used in the table for fiscal years 2000 and 2001 to create a calendar year estimate for 2001. Equipment and software are estimated based on BEA measures.

2.3.3. **Public colleges and universities**

Table 6 translates the Frascati-based intramural expenditures for U.S. Higher Education R&D into a public education component of the general government sector. The expenditure data are based on the NSF's Survey of Research and Development Expenditures at Universities and Colleges and are reported for current expenses, including indirect costs. The translation procedure in this table is repeated in Table 10, where the remainder of Frascati-based expenditures is translated into a private education component of the non-profit sector.

The first adjustment in Table 6 is for R&D performed with general departmental funds. Frascati-based intramural expenditures include all expenditures performed within a statistical unit or sector, regardless of the source of funds (OECD (2002) par. 358). Since NSF's academic survey asks for R&D expenditures that are separately budgeted, expenditures on R&D out of general departmental funds are omitted. While these expenditures are made at universities, no current estimate of their magnitude is available.

The next two adjustments are to align the data to the SNA sectors, in this case to isolate the public higher education component so it can be added to the government

sector. Because they have separate source data, the next subtraction is for expenditures at FFRDCs administered by universities and colleges. While they are included in the OECD's Frascati-based expenditures for Higher Education, expenditures for FFRDCs are assigned to the general government sector in this link and presented separately in Table 5. Since the aggregated data used here was for all colleges and universities, the component that represents public colleges and universities are based on a tabulation of the source data from the Survey of Research and Development Expenditures at Universities and Colleges. University expenditure data have been adjusted by the NSF to remove passthroughs of funds from the university to other colleges and universities. .

The following topic requires no adjustment to the source data, but is discussed for completeness. Frascati-based R&D expenditures should include scholarships and stipends for research conducted by the PhD students (OECD (2002) par. 68, 324) while corresponding measures of R&D on an *SNA* basis would only include this activity when the expenditure took the form of employee compensation. A scholarship that required no formal commitment of labor would not be compensation and, if included in the survey data, should be subtracted. U.S. academic survey data exclude fellowships and scholarships, but do include teaching and research assistantships. Teaching and research assistantships are considered to be employee compensation in the *SNA* (CEC, 1994 par 7.24(e)). Thus the exclusion from U.S. survey data of scholarships and fellowships without a work requirement is consistent with the SNA and no data adjustment is necessary.

The next adjustment in Table 6 is to identify the purchase of R&D used as an input to the R&D process. The NSF survey does not identify the purchases of R&D

services needed to construct a measure of intermediate inputs of R&D, and these are considered to be small by the NSF survey staff.

Three lines in Table 6 follow to insure that any embedded capital expenditures are identified and subtracted. There is no survey question identifying these costs, and as was the case with corporate accounting, these costs may or may not be capitalized and therefore excluded from current costs. While the SNA identifies assets with a useful life of greater than a year as a capital asset, for academic accounting this standard may be applied as well as a threshold value for capitalization that varies from $500 to $10,000.[16] For public colleges and universities, expenditures on research equipment for science and engineering were reported at $1,088 million for 2001, this value is subtracted in Table 6. Any embedded costs for purchased software should also be subtracted. Because of the uncertainty surrounding the magnitude of these embedded costs, no estimate of these embedded software costs is currently included in the translation tables.

The next section of Table 6 contains the adjustments that move current expenditures to a fuller measure of the value of output. Since the academic form includes indirect costs, which are assumed to include depreciation, the historic cost measure of depreciation embedded in these performance expenditures is subtracted based on estimates from an estimate provided by NSF from fiscal year 1997 of the depreciation and use share of indirect costs for public universities (2.7%). The adjustment for consumption of fixed capital is made based on BEA estimates of investment and depreciation as described earlier, using the investment ratios to output of NAICS 5417 and the CFC rates from general government from the NIPAs. The final line before the

[16] GASB 35, Depreciation and Infrastructure Requirements, indicate that equipment purchases over $5,000 must be capitalized and depreciated, as well as some purchased or developed software with costs over $1,000,000.

gross output total is a zero adjustment by SNA convention. Since the R&D output of the government sector and the non-profit sector is considered non-market output in this analysis, the SNA calls for a zero net operating surplus.

Section II accounts for R&D transactions between academic institutions and non-resident units, but no information for identifying purchases or sales to foreign entities is available on the academic R&D form. Section III categorizes gross fixed investment. The values for investment in structures ($187 million) and in equipment and software ($1,146 million) are BEA estimates. Although some data are available from the NSF surveys for capital investment, BEA estimates were used because the available survey data for 2001 did not fully match the investment categories. The BEA estimate for equipment and software is similar to the available survey data for equipment ($1,088 million), however, only software embedded in research equipment is included in this measure. The BEA estimate cannot be compared well to the facilities survey data, which describes planned construction projects biennially, rather than actual expenditures.[17] In addition to questions about the square feet of space devoted to science and engineering research, this survey also contained construction, repair, and renovation spending questions up to and including 1998. In 2001 these expenditure questions were dropped but were replaced in the 2003 survey. The most useful information for developing estimates of R&D capital stock would ask respondents for annual capital expenditures for structures, equipment, and software.

[17] The 1998 survey provides data on total project costs for construction projects for science and engineering research facilities that begin in either 1998 or 1999 for public institutions and for private institutions. For public institutions the total for the two years for project cost is $1,810.1 million and for private institutions the total for the two years is $955.3. The source for these totals is Table 25 and Table 26 of NSF (2004c).

2.3.4. State and Local Government

This section describes the NSF data available on the performance of R&D by state and local governments that is conducted separately from that performed in public universities. Since most public universities are state institutions, that component of government-performed R&D activity is captured in the academic R&D performance data and reflected in Table 6. While no annual survey exists for the performance of R&D by state agencies, state surveys have been conducted for the NSF periodically using a framework comparable to other NSF R&D data. The latest NSF-sponsored funder and performer-based survey data are available for state governments for fiscal year 1995. This survey was conducted by the Battelle Group and State Science and Technology Institute (SSTI).

Table 7 starts on line 2 with data from the Batelle survey. The relevant data from this survey for the Frascati-to-SNA link are the data on performance of R&D by state agencies and the state-funded performance of R&D by local governments. These data indicate for fiscal year 1995 that $408 million was spent within the state governments for the performance of R&D and $33 million of state funding was spent in local governments. These values are scaled up for 2001 with the growth rate of state and local government current expenditures from the NIPAs.[18] While the Batelle/SSTI survey provides the only aggregated source data identified for local government R&D activity, they represent only the component of local government R&D that was funded with state dollars.

An adjustment is made to align the scope of state and local R&D to that of the Frascati/*SNA* framework. An estimated share of state and local expenditures for R&D

[18] Table 3.3: 2001 value of 1368.2/1995 value of 978.2

that is devoted to commercialization is subtracted from R&D activity expenditures. The Frascati framework characterizes R&D activity with three subcomponents, basic research, applied research, and experimental development. This framework excludes certain related activities from the scope of R&D, including education, training, and marketing (OECD (2002) par. 66 -70) and tooling up for production processes (OECD (2002) Table 2.3). The Batelle/SSTI survey has a somewhat broader scope of R&D. In addition to basic research, applied research, and development, the survey includes commercialization as a valid component of R&D. For this survey, commercialization is "the reduction to practice of a technical idea, its incorporation into the design or production process of a product or service, and initial introduction of the product or service into a commercial market (Batelle and SSTI (1998) page 25).

The Batelle/SSTI survey provides an estimate of R&D plant that is consistent with that of federal government surveys. It includes facilities and fixed equipment, acquisition, construction, major repairs and alterations. It includes the acquisition of land and excludes movable equipment and equipment (Batelle and SSTI (1998) page 26). The equipment and software investment value is estimated with BEA sources as described earlier.

The NSF is currently developing a prototype survey with the Census Bureau for state governments. This survey would provide information on the funding or performing state government agency, the source of the funds (federal or nonfederal), the recipients or performers of the R&D (intramural use or external industry, academia, or other nonprofit organization), and the character of the R&D work (basic research, applied research, and development).

2.4. Private Non-profit and Household Sector

The scope of the Frascati-based Private Non-profit and Household sector is more limited than the SNA-based Non-profit Institutions Serving Households (NPISH) and Households sector because the Frascati sector does not include private non-profit colleges and universities. The SNA-based sector includes these private non-profit academic institutions, non-profit research institutes, R&D activity conducted by both membership and philanthropic associations that do not serve business, and the non-market R&D activity of households (OECD (2002) par. 194-197).[19] No survey data are available for the non-market R&D activity of households, and it is considered to be small.

The NSF-sponsored Gallup survey, Research and Development Funding and Performance by Nonprofit Organizations, was last conducted in fiscal 1996 and 1997 and has been discontinued. For more recent years, the Frascati-based expenditures for the U.S. are produced by the NSF with an imputation procedure (NSF (2001a)) using the data from the Federal Funds for R&D Survey and the last available survey values.

2.4.1. Non-profit institutions excluding Universities and Colleges

Adjusting for the scope of R&D conducted at non-profits in Table 9 on either a Frascati basis or an SNA basis requires the inclusion of R&D in the humanities and the exclusion of R&D performed by non-profits that primarily serve business.[20] Non-profits that primarily serve business were identified on the last NSF sponsored Gallup survey,

[19] As discussed in Robbins (2006), the sectoring arrangement used for this link is based on the SNA language that identifies R&D produced by government and non-profits as non-market output. Alternate interpretations of *SNA 1993* that focus on the relationship of price to cost could locate many non-profit R&D performers in the corporate sector.

[20] The discontinued survey for nonprofit organizations specifically excludes law, business administration/management science, humanities, most history, the arts, and most education (NSF (2003a), Appendix One).

Research and Development Funding and Performance by Nonprofit Organizations as trade associations and industrial consortiums; their expenditures are moved to the non-financial business sector.

The discontinued non-profit survey provides very limited information for many of the adjustments required to translate the expenditures to an *SNA* basis. The adjustment for the purchase of R&D used as an intermediate input cannot be effectively made since the only relevant question includes pass-throughs as well as vendor relationships and contracts. There are no detailed questions on software or equipment purchases. As with the other sectors, consumption of fixed capital in the link table is estimated for this sector using BEA data.

2.4.2. Non-profit colleges and universities

The translation of Frascati-based expenditures for non-profit colleges and universities in Table 10 is based on the same academic survey as the public colleges and universities and described in section 2.3.3. After subtracting the expenditures for FFRDCs and for public colleges and universities from R&D expenditures performed by higher education institutions, the steps are the same as described in Table 6.

2.5. Rest of World (Exports and Imports)

Table 11 that accompanies this paper consolidates the import and export components from the other tables in order to provide a representation of the R&D flows between resident and non-resident units. The NSF-based survey data have not focused on this component of R&D activity, and thus the data are sparse for most sectors of the

economy. Exports are not only sales of R&D services, but also barter, gifts or grants of R&D services from resident to non-resident units.

The export and import estimates presented in Table 11 are limited measures and based on BEA data rather than NSF-compiled surveys. For the estimate presented in Table 11 for the corporate sector, BEA data on trade in Research and Development and Testing Services are used. The scope of this trade is broader than that of Frascati-based R&D. Trade in R&D services collected by BEA covers "laboratory and other physical research, product development services, and product testing services (BEA (1998))."

For the components of the government sector, data on international transactions are only available based on payments by the federal government to foreign performers of R&D. These payments are counted in Table 11 as R&D imports. Exports and imports of R&D by FFRDCS, academic institutions, non-profits, and state and local government entities can not be identified. For academic institutions, these international transactions could be substantial.

3. Summary

This paper has proposed a sectoring framework to translate existing NSF expenditure data on R&D activity into gross output of R&D on an SNA basis. This is a preliminary step in the capitalization of R&D expenditures.[21] The framework has been applied to U.S. survey data for R&D expenditures collected by the NSF. The sectoring framework adjusts for the differences between the sectors of the *FM* and those of the SNA, and provides a conceptual basis to distinguish market R&D from non-market R&D given

[21] There will be additional data problems associated with capitalization have not been addressed in this paper, particularly those related to the rate of return for different kinds of R&D.

limited information about the R&D transactions characterized in the source data. The tables in this paper apply this framework to U.S. survey data compiled by the NSF. In the process the paper identifies the gaps between the SNA concepts and the source data as well as a few gaps between the Frascati Manual concepts and the source data.

The RD-1 survey provides most of the components of expenditure needed for creating an SNA-based measure of output for corporate R&D. The NSF academic survey similarly provides most of the components of output for academic R&D. Survey data are limited for non-profits, federally funded research and development centers, and state and local government R&D. While sectors like the non-profits and state and local government that perform a smaller component of U.S. R&D are covered infrequently by NSF surveys, the largest components of U.S. R&D performance, that conducted by private industry, universities and colleges, and the agencies of the federal government, are covered by good annual surveys. However, the translation of these expenditures to gross output will require some adjustments that are not available in the source data.

The Frascati Framework includes R&D in the social sciences, and this standard is not consistently maintained across the NSF-compiled surveys. While the impact of this exclusion on corporate R&D cannot readily be determined, it clearly implies an underestimate of R&D.

The Frascati framework provides many of the components of cost needed to build up the value of output based on input costs, but not all. While not included as part of Frascati expenditures, consumption of fixed capital can be estimated well if good data exist on capital investment each year and prices are available for used capital. Historical cost depreciation is a usable, though imperfect substitute for consumption of fixed capital

and both the RD-1 survey and the NSF academic survey ask for estimates of historical depreciation.

An important feature of the Frascati framework is that it identifies the major components of gross fixed investment, structures, equipment, and software. In addition to additional survey data on these types of capital expenditures, improved detail on expensed software and equipment would be helpful for all of these NSF-compiled surveys. For all of the NSF surveys, some of the most useful information for developing estimates of R&D capital stock would ask respondents for annual capital expenditures for structures, equipment and software, but this has been described as some of the most burdensome information for respondents to provide.[22]

While in general the Frascati framework on performance and funding of R&D obscures the nature of the economic transaction between funder and performer that is crucial for determining who owns or gains the economic benefit from the R&D, *FM* provides for a distinction in types of government funding that would improve these link tables substantially if implemented for U.S. survey data. The FM recommendation is that two categories of government funding (procurement and transfers) be identified for R&D performed in the business sector and in the academic sector. Additional information than that currently available from the survey data is necessary to establish the "ownership" of R&D that would be used for measures of R&D capital stocks. The data as they currently exist imply two less than ideal alternative conclusions; either the funder of the R&D owns it, or the performer of the R&D owns it. An SNA-based set of R&D accounts needs to identify the economic transactions between funder and performer. Specifically,

[22] Brown, Plewes and Gerstein (2004) page 133.

when the federal government funds R&D performed by others, grants, subsidies and transfers should be separated from intermediate purchases.

The recent interest in improved measures of international flows of R&D is unlikely to fade, and improvements in these measures across the sectors would benefit an SNA-based accounting of exports and imports of R&D. Although the Frascati Manual suggests a framework for international R&D flows, the focus of Frascati-based data collection has thus far led to limited reporting of international transactions in R&D. The RD-1 form does ask about international funding, but its wording does not allow the information to be translated to imports and exports. Improving the estimates of capital expenditures, economic transactions, and trade in R&D services for all sectors would be a valuable improvement to the Frascati framework that would allow it to better translate to the *SNA*.

Frequently Used Acronyms

FM: Frascati Manual
FFRDCs: Federally Funded Research and Development Centers
CFC: Consumption of Fixed Capital
OECD: Organization for Economic Co-operation and Development
NAICS: North American Industry Classification System
NPISH: Non Profit Institutions Serving Households
R&D: Research and Development
SNA: System of National Accounts

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Table	Description
Summary Table C	Sector Summary of R&D Gross Output for U.S. in $ millions, current dollar
Summary Table D	Summary of Differences between 2001 R&D Expenditures and 2001 Gross Output
1	Business Sector to Nonfinancial Corporate Sector
2	Business Sector to Financial Corporate Sector
3	Government Sector to General Government Sector
4	Federal Government to General Government Subtable
5	Federally Funded R&D Centers to General Government Subtable
6	Higher Education Sector to General Government Subtable
7	State and Local Government to General Government Subtable
8	Private Non-Profit Sector to Non-profits Serving Households Sector
9	Private Non-Profit Organizations Subtable
10	Higher Education Sector to Non-profit Higher Education Subtable
11	Abroad to Rest of World Sector

R&D Link Tables for U.S.: Frascati-based Expenditures to SNA-based Gross Output

C. Sector Summary of 2001 R&D Performance Expenditures for U.S. in $ millions, current dollar

	Nonfinancial Corporate	Financial Corporate	General Government	Non-profit Institutions Serving Households	
	Table 1	Table 2	Table 3	Table 8	Total
I. Gross Output of R&D Services					
	202,747	2,403	59,915	20,872	285,936
II. Net Exports					
	4,321	-	(440)	-	3,881
IV. Net Additions to Capital					
	12,498	154	4,602	1,350	18,604

D. Summary of Differences: 2001 R&D Expenditures and 2001 Gross Output

	Nonfinancial Corporate	Financial Corporate	General Government	Non-profit Institutions Serving Households	Total
I. GERD (Note 1)	196,541	2,349	54,989	20,826	274,705
II. Scope adjustments +			874	192	1,066
III. Intermediate Inputs +	2,856	31	3,352	-	6,239
IV.Embedded additions to Gross Fixed Capital -	-	-	2,673	460	3,133
V. Adjustments to move from expenditures to value of output +	3,349	23	2,726	314	6,412
VI. State and Local R&D +			647		647
VII.Gross Output Total	202,747	2,403	59,915	20,872	285,936

Note 1. GERD is the Frascati-based total for U.S. performance of R&D. It is equal to the Total U.S. Expenditure on R&D in current dollars for 2001 ($274,211 million) plus the estimate of federal government capital expenditure for 2001 ($494 million).

Table 1 Business Sector to Nonfinancial Corporate Sector

		Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
	I. Output					
1	Frascati-Based Expenditures	**Gross Expenditures on R&D (GERD) performed by the business sector**	200,525	OECD (2004), Main Science and Technology Indicators, Electronic Version (mst2004.xls, worksheet 49A-HP_RS) and "National Patterns, Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS (2004a).		This is the sum of industry performed R&D and Industry FFRDCs
2	Minus expenditures for FFRDCs run by industries.	-	2,020	NSF (2003a), National Patterns of R&D Resources: 2002 Data Update, Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS	The Frascati-based numbers from the OECD include the expenditures of FFRDCs run by corporations in the business sector. They will be moved to Table 5.	
3	Minus expenditures for financial corporations	-	2,349	Tabulation of NSF data for financial corporations.	This sector is non-financial corporations only.	
4	Plus business expenditures for R&D in areas not covered by NSF survey data: Humanities, Social Sciences	+		No survey data	The Frascati definition of R&D includes the Humanities and Social Sciences, this is a data source adjustment, rather than Frascati to SNA adjustment.The RD-1 excludes R&D in the humanities and social sciences.	
5	Plus expenditures for non-profits serving business	+	385	Research and Development Funding and Performance by Nonprofit Organizations, NSF(2001b)Table A-11. The business sector component is identified in the 1996 and 1997 data as trade associations and industrial consortiums. The ratio of these associations to total respondents is applied to the Non-profit performance expenditures to estimate this share.	Both Frascati and SNA assign the non-profits serving business to the business or corporate sector. The NSF-based data assign them to the non-profit sector.	
6	Plus R&D purchased as an intermediate input to production of R&D in the corporate sector	+	2,856	2001 Survey of Industrial R&D; RD1 Question 8 (B) parts 1, 2, and 3. Each sector's purchase of R&D from private companies is suppressed for confidentiality. The total is divided between financial and non-financial companies in proportion to R&D output.	SNA-based gross output includes intermediate consumption, including the cost of any purchased R&D	
7	Plus drawing down of materials and supplies inventories	+	0	No survey data	Materials and supplies purchased in a prior period and used for R&D production in the current period should be added to output.	Likely quite small
8	**Remove any embedded additions to gross capital**					
9	Subtract software purchases	-		These expenditures cannot be separated out based on the RD-1 survey form (memo from J. Jankowski and F. Moris, 1/25/05).	Software is considered as investment in the SNA and expenditures for its purchase need to be subtracted from current expenses to avoid double-counting.	Question 4 could ask for purchases of software, or the instructions could specify that software purchases should be excluded.
10	Subtract expenditures that are additions to materials and supplies inventories	-	0	No survey data	Expenditures for materials and supplies that are not used in the current period for R&D output should be subtracted from the output measure and counted as investment in inventories.	Likely quite small
11	**Adjustments to move from expenditures to full value of output**					
12	Minus historical cost depreciation	-	*7,041*	This is an estimate based on RD-1 question 6D, depreciation on R&D property and equipment and is subtracted to avoid a double count with the entry below. Data from 2000 is included in the calculation to estimate suppressed values.	SNA-based CFC is calculated based on current cost.	
13	Plus Consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D in the US.	+	10390	Estimated with NIPA CFC at current cost and the estimated investment from section III.	The SNA includes consumption of fixed capital valued at current cost, the RD-1 numbers use the historical depreciation estimate in its place.	
14	Plus other taxes on production less subsidies	+		No survey data		
15	Plus Net Operating Surplus	+		No survey data	The mark up or net operating surplus is part of the full value of output for market production.	
16	Gross Output		202,747			

R&D Link Tables for U.S.: Frascati-based Expenditures to SNA-based Gross Output

Table 1 Business Sector to Nonfinancial Corporate Sector

		Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
17	**II. Exports and Imports of R&D Output**					
18	R&D receipts	**Exports**				A question about R&D performed then sold to a nonresident entity would be useful.
19	Affiliated Trade in R&D Services --receipts	+	5,700	BEA: U.S. International Services: Cross-Border Trade in 2004 and Sales Through Affiliates in 2003. SCB, October 2005, Table 1		
20	Plus_Unaffiliated Trade in R&D Services--receipts	+	1,046	BEA: U.S. International Services: Cross-Border Trade in 2004 and Sales Through Affiliates in 2003. SCB, October 2005, Table 1		
21	R&D Payments	**Imports**				While the RD-1 form asks about funding of foreign R&D, it does not ask about R&D purchased from a foreign entity. Question 8(B) could include an entry for purchases from nonresident entities.
22	Affiliated Trade in R&D Services --payments	-	1,700	BEA: U.S. International Services: Cross-Border Trade in 2004 and Sales Through Affiliates in 2003. SCB, October 2005, Table 1		
23	Unaffiliated Trade in R&D Services--payments	-	725	BEA: U.S. International Services: Cross-Border Trade in 2004 and Sales Through Affiliates in 2003. SCB, October 2005, Table 1		
24	Subtotal		4,321			
25	**III. Gross Capital Formation**					
26		**Fixed Investment**				
27	Investment in structures	+	*1,753*	No survey data	This estimate is based on the ratio of investment in structures to gross output for NAICS 5417	A separate expenditure question would be useful.
28	Investment in Equipment	+	*10,745*	No survey data	This estimate is based on the ratio of investment to gross output for NAICS 5417, and is for both equipment and software	A separate expenditure question would be useful.
29	Investment in Software	+	0	The amount of software expenditures embedded in the performance numbers cannot be estimated based on the survey form.		A separate expenditure question would be useful.
30	Net Disposals	-		No survey data		
31	Fixed Investment Subtotal		*12,498*			
32	Investment in inventories	+	**Inventory Change**	no appropriate question to identify these expenditures		Likely very small
33	Gross Capital Formation		*12,498*			

Table 2 Business Sector to Financial Corporate Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
	I. Output						
1	Frascati-Based Expenditures		**Gross Expenditures on R&D (GERD) performed by the business sector**	200,525	OECD Table 2 for 2001 and 'NSF/DSRS (2003a), National Patterns of R&D Resources: 2002 Data Update, Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS		
2	Minus expenditures for FFRD Centers run by industries.	-		2,020	NSF/DSRS (2003a), *National Patterns of R&D Resources: 2002 Data Update,* Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS	The Frascati-based numbers from the OECD include the expenditures of FFRDCS run by corporations in the business sector. They will be moved to Table 5.	
3	Minus expenditures for non-financial corporations	-		196,156		This sector is financial corporations only.	
4	Plus business expenditures for R&D in areas not covered by NSF survey data: Humanities, Social Sciences	+			No survey data	The Frascati definition of R&D includes the Humanities and Social Sciences, this is a data source adjustment, rather than Frascati to SNA adjustment. The RD-1 excludes R&D in the humanities and social sciences.	While the RD-1 does not go to firms classified as in the Agriculture sector, NAICS 5417, most agriculture related R&D is done by firms classified in other covered industries.
5	Plus R&D purchased as an intermediate input to production of R&D in the corporate sector	+		31	2001 Survey of Industrial R&D; RD1 Question 8 (B) parts 1, 2, and 3. Each sector's purchase of R&D from private companies is suppressed for confidentiality. The total is divided between financial and non-financial companies based proportional to R&D output.	SNA-based gross output includes intermediate consumption, including the cost of any purchased R&D	
6	Plus drawing down of materials and supplies inventories	+		-	No survey data	Materials and supplies purchased in a prior period and used for R&D production in the current period should be added to output.	Likely quite small
7	**Remove any embedded additions to gross capital**						
8	Minus software purchases	-			These expenditures cannot be separated out based on the RD-1 survey form (memo from J. Jankowski and F. Moris, 1/25/05).	Software is considered as investment in the SNA and expenditures for its purchase need to be subtracted from current expenses to avoid double-counting.	Question 4 could ask for purchases of software, or the instructions could specify that software purchases should be excluded.
9	Subtract expenditures that are additions to materials and supplies inventories	-		0	No survey data	Expenditures for materials and supplies that are not used in the current period for R&D output should be subtracted from the output measure and counted as investment in inventories.	Likely quite small
10	**Adjustments to move from expenditures to full value of output**						
11	Minus historical cost depreciation	-		105	This is an estimate based on RD-1 question 6D, depreciation on R&D property and equipment and is subtracted to avoid a double count with the entry below. Data from 2000 is included in the calculation to estimate suppressed values.	SNA-based CFC is calculated based on current cost.	
12	Plus Consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D in the US.	+		*128*	Estimated with NIPA current cost CFC to investment ratio for private nonresidential investment using the estimated investment from section II.	The SNA includes consumption of fixed capital valued at current cost, the RD-1 numbers use the historical depreciation estimate in its place	
13	Plus other taxes on production less subsidies	+		0	No survey data		
14	Plus Net Operating Surplus	+		0	No survey data	The mark up or net operating surplus is part of the full value of output for market production.	
15	Gross Output			2,403			

Table 2 Business Sector to Financial Corporate Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
16	**II. Exports and Imports of R&D Output**						
17			**Exports**				A question about R&D performed then sold to a nonresident entity would be useful.
18	Affiliated Trade in R&D Services -- receipts	+		0			
19	Plus Unaffiliated Trade in R&D Services--receipts	+		0			
20			**Imports**				While the RD-1 form asks about funding of foreign R&D, it does not ask about R&D purchased from a foreign entity. Question 6(B) could include an entry for purchases from nonresident entities.
21	Affiliated Trade in R&D Services -- payments	-		0			
22	Unaffiliated Trade in R&D Services-- payments	-		0			
23	Net Exports			0			
24	**III.Gross Capital Formation**						
25			**Fixed Investment**				
26	Investment in structures	+		*22*	No survey data	This estimate is based on the ratio of investment in structures to gross output for NAICS 5417.	
27	Investment in Equipment	+		*133*	No survey data	This estimate is based on the ratio of investment to gross output for NAICS 5417, and is for both equipment and software.	
28	Investment in Software	+			The amount of software expenditures embedded in the performance numbers cannot be estimated based on the survey form.		
29	Net Disposals	-			No survey data		Likely very small
30	Fixed Investment Subtotal						
31	Investment in inventories	+	**Inventory Change**		no appropriate question to identify these expenditures		Likely very small
32	Gross Capital Formation			*154*			

Table 3 Total General Government Sector

		Components	2001 Amount in millions of Current Dollars	Data or Survey Source
1	I. Output			
2	+	Federal Government	24,529	Table 4
3	+	FFRDCs	11,438	Table 5
4	+	Government Higher Education	23,301	Table 6
5	+	State and Local Government	647	Table 7
6	Gross Output		59,915	
7	**II. Net Exports of R&D Output**			
8	+	Federal Government	(440)	Table 4
9	+	FFRDCs	-	Table 5
10	+	Government Higher Education	-	Table 6
11	+	State and Local Government	-	Table 7
12	Net Exports		(440)	
13	**III. Gross Capital Formation**			
14	+	Federal Government	1,586	Table 4
15	+	FFRDCs	1,602	Table 5
16	+	Government Higher Education	1,333	Table 6
17	+	State and Local Government	81	Table 7
18	Gross Capital Formation		4,602	

Table 4 General Government Sector to General Government Sector, Federal Government Performance

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
	I. Output						
1	Frascati-Based Expenditures		**Gross Expenditures on R&D (GERD) performed by the Government sector**	21,542	OECD's Main Science and Technology Indicators, ('mst2004.xls, worksheet 52A-GV_NC) and National Patterns, Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS. The NSF adds an adjustment for capital expenditures.		This is "federal intramural" R&D; R&D performed by the agencies of the federal government.
2	R&D purchased as an intermediate input to production of R&D	+		*3,352*	No survey data. The estimate is made based on federally funded performance of R&D in industry 5417 from NSF/DSRS (2004a); Science and Engineering Indicators 2004, Arlington, VA (NSF 04-01) [May 2004]. page 4-16.	SNA-based gross output includes intermediate consumption, including the cost of any purchased R&D. This is a measure of government purchases of the output of contract R&D industry.	The Frascati Manual provides for classification of federal expenditures for R&D based on whether they are for procurement or are a transfer of funds. A question similar to that on the RD-1 survey would be useful here.
3	Plus drawing down of materials and supplies inventories	+		0	No survey data	Materials and supplies purchased in a prior period and used for R&D production in the current period should be added to output.	Likely quite small
4	**Remove any embedded additions to gross capital**						
5	Minus capital expenditures, including those for land and structures	-		494	Intramural R&D; Fiscal years are converted to calendar years as CY 2001 = .75FY2001 + .25FY2002; from Table C-2.Summary of Federal funds for research and development and for R&D plant: fiscal years 2001, 2002, and 2003; and fiscal years 2002, 2003, and 2004. NSF/DSRS (2004a): Federal Funds for Research and Development: Fiscal Years 2001, 2002, and 2003; (NSF 04-310)	'FM includes all expenditures, including those for capital assets, SNA excludes expenditures for capital assets. This line subtracts expenditures for R&D plant.	This is structures and large fixed equipment.
6	Minus current expenditures for non-plant machinery and equipment, as well as purchased software	-		*1,092*	No survey data, estimated with ratio of equipment and software to gross output for NAICS 5417	SNA current expenditures excludes capital assets, non-plant test equipment in these totals and should be excluded. Software is considered as investment in the SNA and expenditures for its purchase need to be subtracted from current expenses to avoid double-counting.	A question about purchases of capitalized equipment and software would be useful here.
7	Subtract expenditures that are additions to materials and supplies inventories	-		0	No survey data	Expenditures for materials and supplies that are not used in the current period for R&D output should be subtracted from the output measure and counted as investment in inventories.	Likely quite small
8	**Adjustments to move from expenditures to full value of output**						
9	Plus consumption of fixed capital	+		*1,221*	CFC estimate based on BEA measures of capital stocks for equipment and software, and survey-based measures for structures, using depreciation rates for general government (0.906 for equipment and software, 0.469 for structures)	The SNA includes consumption of fixed capital as part of the total production cost.	
10	Plus other taxes on production less subsidies	+		-			
11	Plus Net Operating Surplus	+		-		SNA stipulates no net operating surplus for nonmarket output.	
12	Gross Output			24,529			

Table 4 General Government Sector to General Government Sector, Federal Government Performance

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
13	**II. Exports and Imports of R&D**						
14	1. Plus receipts for trade in R&D services	+			No survey data.		A question about R&D sold to nonresident entities would be useful.
15	2. Minus payments for trade in R&D services	-		440	This is R&D by foreign performers. From Table C-2.Summary of Federal funds for research and development and for R&D plant: fiscal years 2001, 2002, and 2003; and fiscal years 2002, 2003, and 2004. NSF/DSRS (2004a): Federal Funds for Research and Development: Fiscal Years 2001, 2002, and 2003; Arlington, VA (NSF 04-310) [April 2004], 2002, 2003, 2004 update provided by Ron Meeks of NSF.		Since this excludes R&D performed by the U.S. government and its agencies abroad, it undercounts imports characterized as payments to nonresident entities.
16	Subtotal			(440)			
17	**III. Gross Capital Formation**						
18			**Fixed Investment**				
19	Investment in structures	+		494	Intramural R&D; Fiscal years are converted to calendar years as CY 2001 = .75FY2001 + .25FY2002; from Table C-2.Summary of Federal funds for research and development and for R&D plant: fiscal years 2001, 2002, and 2003; and fiscal years 2002, 2003, and 2004. NSF/DSRS (2004a): Federal Funds for Research and Development: Fiscal Years 2001, 2002, and 2003; (NSF 04-310)	Although this measure includes land, the SNA allows the total to be used as long as the value of the land is considered less than half of total	This is plant and fixed equipment
20	Investment in equipment	+		1,092	No separate survey data. Estimated with ratio of equipment and software to gross output for NAICS 5417		A separate expenditure question would be useful.
21	Investment in software	+					A separate expenditure question would be useful.
22	Net Disposals	-		-	No separate survey data		likely very small
23	Fixed Investment Subtotal			1,586			
24	Investment in inventories	+	**Inventory Change**		No separate survey data		likely very small
25	Gross Capital Formation			1,586			

Table 5 Federally Funded R&D Centers from other sectors to General Government Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
	I. Output						
1	Run by Corporations	+	**FFRDCS**	2,020	National Patterns of R&D., Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS (2003a). From FY 2001 forward these data come from an abbreviated version of the NSF Survey of Research and Development Expenditures at Universities and Colleges	Because finance and control come from the Federal Government, these FFRDCS are moved to the Government Sector for SNA-based sectors.	
2	Run by Universities	+	**FFRDCS**	6,225			
3	Run by Non-profits	+	**FFRDCS**	2,192			
4	Plus R&D purchased as an intermediate input to the production of R&D at FFRDCs	+			No survey data	Gross output includes the cost of intermediate inputs used in the production of R&D, this entry reflects the acquisition of R&D services used in producing R&D output.	A question similar to that on the RD-1 survey would be useful here.
4	Plus drawing down of materials and supplies inventories	+		0	No survey data	Materials and supplies purchased in a prior period and used for R&D production in the current period should be added to output.	Likely quite small
5	**Remove any embedded additions to gross capital**						
5	Minus current expenditures for non-plant machinery and equipment	-			No survey data.	Uncapitalized research equipment with a useful life of more than one year is considered capital under the SNA and must be removed from current expenses.	Instructions to exclude capitalized equipment or a question about purchases of capitalized equipment would be useful here.
6	Minus software purchases	-			No survey data.	Software is considered as investment in the SNA, thus uncapitalized expenditures for software need to be subtracted to avoid double-counting.	Instructions to exclude software or a question about purchases of capitalized software would be useful here.
7	Subtract expenditures that are additions to materials and supplies inventories	-		0	No survey data	Expenditures for materials and supplies that are not used in the current period for R&D output should be subtracted from the output measure	Likely quite small
8	**Adjustments to move from expenditures to full value of output**						
9	Minus historical cost depreciation	-			Item 1 on the NSF form for R&D at FFRDCs asks for total current fund expenditures including indirect costs; these are assumed to include depreciation charges, however they are not separately reported.		A question similar to that on the RD-1 survey would be useful here.
10	Plus Consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D performed in the US.	+		*1,001*	CFC estimate based on BEA measures of capital stocks for equipment and software, and for structures, using depreciation rates for general government (0.906 for equipment and software, 0.469 for structures)	The SNA includes consumption of fixed capital as part of the total production cost.	
11	Plus other taxes on production less subsidies	+					
12	Plus Net Operating Surplus	+				SNA stipulates no net operating surplus for nonmarket output.	
13	Gross Output			11,438			

Table 5 Federally Funded R&D Centers from other sectors to General Government Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
14	**II. Exports and Imports of R&D Output**						
15	1. Plus receipts for trade in R&D services	+			No survey data	SNA-based output includes that sold to non-resident units	A question about the sale of R&D services to nonresident entities would be useful here.
16	2. Minus payments for trade in R&D services	-			No survey data	Purchases of R&D output from non-resident units should be subtracted from Gross output	A question about the purchase of R&D services from nonresident entities would be useful here.
	Net Exports						
17	**III. Gross Capital Formation**						
18	Investment in structures	+		1,032	Table C-2.Summary of Federal funds for research and development and for R&D plant: fiscal years 2001, 2002, and 2003; and fiscal years 2002, 2003, and 2004. NSF/DSRS (2004a): Federal Funds for Research and Development: Fiscal Years 2001, 2002, and 2003; Arlington, VA (NSF 04-310) [April 2004], 2002, 2003, 2004 update provided by Ron Meeks of NSF.	Although this measure includes land, the SNA allows the total to be used as long as the value of the land is considered less than half of total	This is plant and fixed equipment
19	Investment in equipment	+		*571*	No survey data	This is an estimate for equipment and software based on BEA data.	A separate expenditure question would be useful.
20	Investment in software	+			No survey data		A separate expenditure question would be useful.
21	Net Disposals	-			No survey data		Likely quite small
22	Fixed Investment Subtotal			1,602			
23	Investment in inventories	+	**Inventory Change**	-	No survey data		Likely quite small
24	Gross Capital Formation			1,602			

Table 6 Higher Education Sector to General Government Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
	I. Output						
1	Frascati-Based Expenditures	+	**Gross Expenditures on R&D (GERD) performed by the Higher Education Sector**	39,744	OECD, Main Science and Technology Indicators, Electronic Version (mst2004.xls, worksheet 49A-HP_RS) and "National Patterns, Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS. The underlying source is NSF form 411, Survey of Research and Development at Universities and Colleges.		Notes attached to the expenditure data note that it excludes most or all capital expenditure.
2	Plus R&D performed with Departmental Funds not separately budgeted for R&D	+		0	No survey data.	Survey data excludes R&D performed with departmental funds that are not separately budgeted for R&D.	
3	Minus expenditures for Federally Funded R&D Centers administered by colleges and universities	-		6,225	'National Patterns, Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from NSF/DSRS (2003a).		These expenditures are entered separately with the other FFRDCs.
4	Minus expenditures at Private Colleges and universities	-		10,509	Special tabulation of NSF form 411, Survey of Research and Development at Universities and Colleges	Only the public universities are assigned to the government sector.	This is based on the academic expenditure ratios that exclude academic passthroughs.
5	Plus R&D purchased as an intermediate input to the production of R&D at universities and colleges	+		0	No survey data.	Gross output includes the cost of intermediate inputs, this entry reflects the acquisition of R&D services used in producing R&D output.	NSF considers this to be small.
6	Plus R&D in Non-Science and Engineering	+		874	Special tabulation of NSF form 411, Survey of Research and Development at Universities and Colleges	The Frascati definition of R&D includes the Humanities and Social Sciences, this is a data source adjustment, rather than Frascati to SNA	
7	Plus drawing down of materials and supplies inventories	+		0	No survey data	Materials and supplies purchased in a prior period and used for R&D production in the current period should be added to output.	Likely quite small
8	**Remove any embedded additions to gross capital**						
9	Minus current expenditures for equipment	-		1,088	Item 3j on the NSF form for R&D at Universities and Colleges, this is equipment used in Science and Engineering. Special tabulation from NSF	Uncapitalized research equipment with a useful life of more than one year is considered capital under the SNA and must be removed from current expenses.	Instructions to exclude capitalized equipment or a question about purchases of capitalized equipment would be useful here.
10	Minus software purchases	-		-	No survey data.	Software is considered as investment in the SNA, thus uncapitalized expenditures for software need to be subtracted to avoid double-counting.	Instructions to exclude software or a question about purchases of capitalized software would be useful here.
11	Subtract expenditures that are additions to materials and supplies inventories	-		0	No survey data	Expenditures for materials and supplies that are not used in the current period for R&D output should be subtracted from the output measure	Likely quite small

Table 6 Higher Education Sector to General Government Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
12	**Adjustments to move from expenditures to full value of output**						
13	Minus historical cost depreciation	-		621	This is an NSF provided estimate from FY 1997 of depreciation and use share of indirect costs on R&D totals for public universities (2.7%).	This step subtracts historical-based depreciation, it will be offset below with a current cost estimate that is consistent with the SNA.	A question similar to that on the RD-1 survey would be useful here.
14	Plus Consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D performed in the US.	+		*1,126*	CFC estimate based on BEA measures of capital stocks for equipment and software, and for structures, using depreciation rates for general government (0.906 for equipment and software, 0.469 for structures)	The SNA includes consumption of fixed capital as part of the total production cost.	
15	Plus other taxes on production less subsidies	+		0			
16	Plus Net Operating Surplus	+		0		SNA stipulates no net operating surplus for nonmarket output.	
17	Gross Output			23,301			
18	**II. Exports and Imports of R&D Output**						
19	Receipts for Trade in R&D Services from foreign sources	+			No survey data.		A question about the sale of R&D services to nonresident entities would be useful here.
20	Payments for trade in R&D Services to foreign performers	-			No survey data.		A question about the purchase of R&D services from nonresident entities would be useful here.
21	Subtotal			-			
22	**III. Gross Capital Formation**						
23	Investment in structures	+		*187*	This is a BEA estimate, NSF Survey data from the Scientific and Engineering Research Facilities Survey provides total project costs, not annual expenditures.		A separate expenditure question would be useful.
24	Investment in equipment	+		*1,146*	This is a BEA estimate for equipment and software		Item 3a on the NSF form for R&D at Universities and Colleges is 1,088 .
25	Investment in software	+		0	No survey data, estimated above with equipment.		A separate expenditure question would be useful.
26	Net Disposals	-			No survey data.		Likely quite small
27	Fixed Investment Subtotal			*1,333*			
28	Investment in inventories	+	**Inventory Change**		No survey data.		Likely quite small
29	Gross Capital Formation			*1,333*			

Table 7 State and Local Government Sub-sector

		Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
I. Output						
1 Frascati-Based Expenditures				None Available		
2 Plus government expenditures for R&D in areas not covered by NSF survey data	+	State and State-funded Local Government Performance	618	Table 95.4a Battelle and State Science and Technology Institute (1998). "Survey of State Research and Development Expenditures: Fiscal Year 1995." Report dated September 1998.	1995 values scaled up with growth in state and local current expenditures from NIPA Table 3.3.	
3 Minus expenditures for Commercialization included in the performance data	-		23	Table 95.1a provides state expenditures for R&D by character of work from all sources of funds. The ratio of commercialization funds to total is estimated (3.8%) and applied to state performed and state-funded local government performance.	This is a data source adjustment not a Frascati-to-SNA adjustment. Frascati-based R&D excludes commercialization expenses.	
4 Plus R&D purchased as an intermediate input to the production of R&D	+		0	No survey data.	Gross output includes the cost of intermediate inputs, this entry reflects the acquisition of R&D services used in producing R&D output.	A question similar to that on the RD-1 survey would be useful here.
5 Plus drawing down of materials and supplies inventories	+		0	No survey data	Materials and supplies purchased in a prior period and used for R&D production in the current period should be added to output.	Likely quite small
6 **Remove any embedded additions to gross capital**						
7 Minus current expenditures for equipment	-		0	No survey data.	Uncapitalized research equipment with a useful life of more than one year is considered capital under the SNA and must be removed from current expenses.	Instructions to exclude capitalized equipment or a question about purchases of capitalized equipment would be useful here.
8 Minus software purchases	-		0	No survey data.	Software is considered as investment in the SNA, thus uncapitalized expenditures for software need to be subtracted to avoid double-counting.	Instructions to exclude software or a question about purchases of capitalized software would be useful here.
9 Subtract expenditures that are additions to materials and supplies inventories	-		0	No survey data	Expenditures for materials and supplies that are not used in the current period for R&D output should be subtracted from the output measure	Likely quite small
10 **Adjustments to move from expenditures to full value of output**						
11 Plus Consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D performed in the US.	+		53	CFC estimate based on BEA measures of capital stocks for equipment and software, and for structures, using depreciation rates for general government (0.906 for equipment and software, 0.469 for structures)	The SNA includes consumption of fixed capital as part of the total production cost.	

Table 7 State and Local Government Sub-sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
12	Plus other taxes on production less subsidies	+		0			
13	Plus Net Operating Surplus	+		0		SNA stipulates no net operating surplus for nonmarket output.	
14	Gross Output			647			
15	**II. Exports and Imports of R&D Output**						
16	Receipts for Trade in R&D Services from foreign sources	+			No survey data.		A question about the sale of R&D services to nonresident entities would be useful here.
17	Payments for trade in R&D Services to foreign performers	-			No survey data.		A question about the purchase of R&D services from nonresident entities would be useful here.
18	Net Exports			-			
19	**III. Gross Capital Formation**						
20	Investment in structures	+		47			
21	Investment in equipment	+		*34*	This is a BEA estimate for equipment and software		A separate expenditure question would be useful.
22	Investment in software	+			Estimated with equipment above		A separate expenditure question would be useful.
23	net disposals	-			No survey data.		Likely quite small.
24	Fixed Investment Subtotal			*81*			
25	Investment in inventories	+	**Inventory Change**	0	No survey data.		Likely quite small.
26	Gross Capital Formation			*81*			

Table 8 Total Non-profits and Household Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
1	I. Output						
2		+	Non-Profit Institutions Serving Households	10,601	Table 9		
3		+	Non-Profit Higher Education	10,271	Table 10		
4		+	Non-market Household production		No survey or estimate available	R&D activity conducted by households that is not sold in the market	Likely quite small.
5	Gross Output			20,872			
6	II. Exports and Imports of R&D Output						
7		+	Non-Profit Institutions Serving Households	0	Table 9		
8		+	Non-Profit Higher Education	0	Table 10		
9		+	Non-market Household production		No survey data	R&D activity conducted by households that is not sold in the market	Likely quite small.
10	Net Exports			0			
11	III. Gross Capital Formation						
12		+	Non-Profit Institutions Serving Households	705	Table 9		
13		+	Non-Profit Higher Education	645	Table 10		
14		+	Non-market Household production		No survey data	R&D activity conducted by households that is not sold in the market	Likely quite small.
15	Gross Capital Formation			1,350			

Table 9 Non-profit Sector to Households and Non-profit Institutions Serving Households Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
	I. Output						
1	Frascati-Based Expenditures		Gross Expenditures on R&D performed by Non-profits	10,702	"National Patterns, Table B1 "National expenditures for R&D by performing sector and source of funding: 1993-2003" from National Science Foundation/DSRS; estimated by the NSF from Federal Sources and the NSF sponsored Gallup survey, Research and Development Funding and Performance by Nonprofit Organizations from 1996 and 1997.		
2	Plus expenditures for R&D in non-science and engineering	+		-	No survey data	The Frascati definition of R&D includes the Humanities and Social Sciences, this is a data source adjustment.	The survey instructions for R&D Funding and Performance by Nonprofit Organizations excludes nonscience & most humanities (NSF 2003a, Appendix One).
3	Minus expenditures by non-profits serving business	-		385	Research and Development Funding and Performance by Nonprofit Organizations, NSF(2001b)Table A-11. The business sector component is identified in the 1996 and 1997 data as trade associations and industrial consortiums. The ratio of these associations to total respondents is applied to the Non-profit performance expenditures to estimate this share.	Both Frascati and SNA assign the non-profits serving business to the business or corporate sector. The NSF-based numbers assign them to the non-profit sector.	These are the non-profits identified as trade associations and industrial consortiums.
4	Plus R&D purchased as an intermediate input to the production of R&D at non-profit institutions	+			No survey data	SNA-based gross output includes intermediate consumption, including the cost of any purchased R&D	A question similar to that on the RD-1 survey would be useful here.
5	Plus any drawing down of inventories	+			No survey data		Likely very small
6	Remove any embedded additions to gross fixed capital						
7	Minus current expenditures for non-plant machinery and equipment			-	No survey data	Uncapitalized research equipment with a useful life of more than one year is considered capital under the SNA and must be removed from current expenses.	Instructions to exclude capitalized equipment or a question about purchases of capitalized equipment would be useful here.
8	Minus software purchases			-	No survey data	Software is considered as investment in the SNA, thus uncapitalized expenditures for software need to be subtracted to avoid double-counting.	Instructions to exclude software or a question about purchases of capitalized software would be useful here.
9	Adjustments to move from expenditures to full value of output						
10	Minus historical cost depreciation	-			Item 1 on the NSF form for R&D at FFRDCs asks for total current fund expenditures including indirect costs; these are assumed to include depreciation charges.		A separate question would be useful here.
11	Plus Consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D performed in the US.	+		284	CFC estimate based on BEA measures of capital stocks for equipment and software, and for structures, using depreciation rates for general government (0.906 for equipment and software, 0.469 for structures)	Not included in Frascati expenditures, and must be added to account for the full value of production.	
12	Plus other taxes on production less subsidies	+		0			
13	Plus Net Operating Surplus	+		0		SNA stipulates no net operating surplus for nonmarket output.	
14	Gross Output			10,601			

Table 9 Non-profit Sector to Households and Non-profit Institutions Serving Households Sector

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
15	**II. Exports and Imports of R&D Output**						
16	Receipts for Trade in R&D Services from foreign sources	+			No survey data	No good measure, these are mixed in with other sources of funds for science and engineering R&D in question 4 of Research and Development Funding and Performance by Nonprofit Organizations.	A question about the sale of R&D services to nonresident entities would be useful here.
17	Payments for trade in R&D Services to foreign performers	-			No survey data	Expenditures on the Survey of Research and Development Funding and Performance by Nonprofit Organizations question 2 include expenditures abroad as well as domestic ones.	A question about the purchase of R&D services from nonresident entities would be useful here.
18	Net Exports						
19	**III. Gross Capital Formation**						
20	Investment in structures	+		*99*	This is a BEA estimate for structures based on the investment to output ratio for R&D services		A separate expenditure question would be useful.
21	Investment in equipment	+		*606*	This is a BEA estimate for equipment and software based on the investment to output ratio for R&D services		A separate expenditure question would be useful.
22	Investment in software	+			No survey data		
23	net disposals	-			No survey data		likely quite small
24	Fixed Investment Subtotal						
25	Investment in inventories	+	**Inventory Change**		No survey data		likely quite small
26	Gross Capital Formation			705			

Table 10 Higher Education Sector to Non-profit Higher Education

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
I. Output							
1	Frascati-Based Expenditures	+	**Gross Expenditures on R&D (GERD) performed by the Higher Education Sector**	39,744	OECD, Main Science and Technology Indicators, Electronic Version (mst2004.xls, worksheet 49A-HP_RS) and ''National Patterns, Table B1 ''National expenditures for R&D by performing sector and source of funding: 1993-2003'' from National Science Foundation/Division of Science Resources Statistics. The underlying source is NSF form 411, Survey of Research and Development at Universities and Colleges.		Notes attached to the expenditure data note that it excludes most or all capital expenditure.
2	Plus R&D performed with Departmental Funds not separately budgeted for R&D	+		0	No survey data.	Survey data excludes R&D performed with departmental funds that are not separately budgeted for R&D.	
3	Minus expenditures for Federally Funded R&D Centers administered by colleges and universities	-		6,225	'National Patterns, Table B1 ''National expenditures for R&D by performing sector and source of funding: 1993-2003'' from National Science Foundation/Division of Science Resources Statistics.		These expenditures are entered separately with the other FFRDCs.
4	Minus expenditures at public colleges and universities	-		23,010	Special tabulation of NSF form 411, Survey of Research and Development at Universities and Colleges	Only the private universities are assigned to the non-profit sector.	This is based on the academic expenditure ratios that exclude academic passthroughs.
5	Plus R&D purchased as an intermediate input to the production of R&D at universities and colleges	+		-	No survey data.	Gross output includes the cost of intermediate inputs, this entry reflects the acquisition of R&D services used in producing R&D output.	Considered to be small.
6	Plus R&D in Non-Science and Engineering	+		192	Special tabulation of NSF form 411, Survey of Research and Development at Universities and Colleges	The Frascati definition of R&D includes the Humanities and Social Sciences, this is a data source adjustment, rather than Frascati to SNA	This figure is not adjusted for non-reporting, and as such is likely an undercount.
7	Plus drawing down of inventories	+			No survey data		Likely very small
8	**Remove any embedded additions to gross fixed capital**						
9	Minus current expenditures for equipment	-		460	Item 3j on the NSF form for R&D at Universities and Colleges, this is equipment used in Science and Engineering. Special tabulation from NSF	Uncapitalized research equipment with a useful life of more than one year is considered capital under the SNA and must be removed from current expenses.	Instructions to exclude capitalized equipment or a question about purchases of capitalized equipment would be useful here.
10	Minus software purchases	-		-	No survey data	Software is considered as investment in the SNA, thus uncapitalized expenditures for software need to be subtracted to avoid double-counting.	Instructions to exclude software or a question about purchases of capitalized software would be useful here.

Table 10 Higher Education Sector to Non-profit Higher Education

			Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
11	**Adjustments to move from expenditures to market price**						
12	Minus historical cost depreciation	-		515	This is an NSF provided estimate from FY 1997 of depreciation and use share of indirect costs on R&D totals for private universities (4.9%).	This step subtracts historical-based depreciation, it will be replaced below with a current cost estimate that is consistent with the SNA.	
13	Plus Consumption of fixed capital on structures, equipment, and software owned by R&D producers and used to perform R&D performed in the US.	+		*545*	CFC estimate based on BEA measures of capital stocks for equipment and software, and for structures, using depreciation rates for general government (0.906 for equipment and software, 0.469 for structures)	Not included in Frascati expenditures, and must be added to account for the full value of production.	
14	Plus taxes on production less subsidies	+		-			
15	Plus Net Operating Surplus	+		-		SNA stipulates no net operating surplus for nonmarket output.	
16	Gross Output			10,271			
17	**II. Exports and Imports of R&D Output**						
18	Receipts for Trade in R&D Services from foreign sources				No survey data		A question about the sale of R&D services to nonresident entities would be useful here.
19	Payments for trade in R&D Services to foreign performers				No survey data		A question about the purchase of R&D services from nonresident entities would be useful here.
20	Subtotal			-			
21	**III. Gross Capital Formation**						
22	Investment in structures	+		*90*	No survey data, this is a BEA estimate.		A separate expenditure question would be useful.
23	Investment in equipment	+		*555*	This is a BEA estimate for equipment and software based on the investment to output ratio for R&D services		Item 3a on the NSF form for R&D at private Universities and Colleges is 460.
24	Investment in software	+			No survey data, estimated above with equipment.		A separate expenditure question would be useful.
25	net disposals	-		-	No survey data		Likely quite small
26	Fixed Investment Subtotal			645			
27	Investment in inventories	+	**Inventory Change**	-	No survey data		Likely quite small
28	Gross Capital Formation			645			

Table 11 Rest of World

		Components	2001 Amount in millions of Current Dollars	Data or Survey Source	Explanation of Adjustment	Comments
	Exports of R&D Services					
1	+	Corporations	6,746	Table 1		
2	+	General Government		Table 4		no survey data
3	+	Households and Non-profits Serving Households		Table 8		no survey data
4	Subtotal		6,746			
	Imports of R&D Services					
5	-	Corporations	2,425	Table 1		
6	-	General Government	440	Table 4		this is for Federal Only
7	-	Households and Non-profits Serving Households		Table 8		no survey data
	Subtotal		2,865			
8	**Net Export Total**		3,881			