An Industry-based R&D Satellite Account

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Abstract

This paper introduces a proposed framework for estimating an Industry-based R&D Satellite Account (IRDSA). The IRDSA builds on the preliminary Research and Development Satellite Account (R&DSA) released in September 2006, and provides industry and commodity detail. It adapts the U.S. input-output (I-O) accounts to present a consistent and systematic framework to assess the role of R&D in the economy at both an industry and commodity level.

The industry approach for including R&D in the industry accounts provides the framework for examining differences among industries' investment in R&D and the impact of these investments on GDP by industry. It shows the sources of R&D output, R&D industry value added (gross output minus intermediate inputs), and R&D final uses. It allows a detailed look at the composition of R&D funding and performance across industries and the development of improved R&D deflators. In the longer term, the framework can be used as a basis for incorporating R&D into the core national economic accounts.

Development of the IRDSA is a necessary first step in the process of incorporating R&D into the core U.S. national economic accounts, and is a continuation of the Bureau of Economic Analysis (BEA) efforts to improve measures of economic activities related to R&D.

Introduction

This paper introduces a proposed framework for estimating an Industry-based R&D Satellite Account (IRDSA). The IRDSA builds on the preliminary Research and Development Satellite Account (R&DSA) released in September 2006, and provides industry and commodity detail. It adapts the U.S. input-output (I-O) accounts to present a consistent and systematic framework to assess the role of R&D in the economy at both an industry and commodity level. Development of the IRDSA is a necessary first step in the process of incorporating R&D into the core U.S. national economic accounts, and is a continuation of the Bureau of Economic Analysis (BEA) efforts to improve measures of economic activities related to R&D.[1]

Like other satellite accounts, the IRDSA provides a more comprehensive measure of an economic activity by bringing together components of that activity wherever they occur throughout the economy, including for example, activities which are internal to the firm and for which there are no observable prices. In this case, the activity is R&D. The IRDSA identifies R&D activities, and presents the data on both an industry and a commodity basis.

Background

There are three approaches to measuring the impact of R&D on GDP: The expenditure approach; the income approach; and the production approach.[2] In September 2006, BEA released the Preliminary Research and Development Satellite Account

[1] Carson, et al, 1994.
[2] The production approach is equivalent to the industry I-O approach.

(R&DSA) for the period 1959-2002.[3] This preliminary R&DSA is based on the National Income and Product Account (NIPA) framework, and presents an expenditure-based set of estimates of R&D investment and gross domestic income of R&D for the total economy. It presents all business sector activity as one aggregate, rather than by detailed industry sector.

The industry approach described here provides a framework for including R&D in the industry accounts in order to examine differences among industries' investment in R&D and the impact of these investments on GDP by industry. This framework is based on the I-O tables, which show the sources of R&D output, R&D industry value added (gross output minus intermediate inputs), and R&D final uses. It allows a detailed look at the composition of R&D funding and performance across industries and the development of improved R&D deflators. In the longer term, the framework can be used as a basis for incorporating R&D into the core national economic accounts.

Current measures of R&D activities in BEA's Accounts

The national economic accounts currently treat R&D expenditures as intermediate inputs. Consequently, for businesses, including government enterprises, R&D expenditures are not included in GDP, and for nonprofit institutions serving households and general government, R&D expenditures constitute one of the costs that are used to indirectly measure output and consumption expenditures

Exports and imports of R&D services are included in estimates of international trade in services, and thus, affect GDP. Separate estimates of royalties and licensing fees,

[3] Okubo, et al, 2006

including transactions for the use of R&D protected by patents, are treated as intermediate costs.

Conceptual Overview

The preliminary R&DSA released in September 2006 is based on the NIPA framework and provides an aggregate measure of R&D investment and its impact on the total economy. The IRDSA is an extension of the preliminary R&DSA. It uses the I-O account to focus on R&D activities by industry. Its primary purpose is to provide a systematic and consistent structure and data set for examining the role of R&D in the economy on both an industry and commodity basis.

Relationship to the I-O accounts

The I-O accounts show the relationships between all the industries in the economy and all the commodities that these industries produce and use. The accounts provide an analytical framework with detailed linkages among industries and between industries and final demand. The estimates of purchases of commodities are shown in producers' prices. The I-O accounts consist of the make table, use table, direct requirements table, total requirements tables, and a capital flow table.

The IRDSA is based on the I-O accounts. It brings together components of R&D activities that occur throughout the economy. It identifies and aggregates R&D activities whether they are purchased from other firms or performed by units in the same firm for internal use (own account) and without observable prices. It presents the data on an

industry and commodity basis. This framework facilitates the estimates of the interdependencies between R&D output and the rest of the economy.

What Is the Same?

The IRDSA uses the overall industry and commodity classification system and the special definitions and conventions of the I-O accounts. BEA produces a standard set of make and use I-O tables. These standard tables measure NAICS-industry output as the total of all goods and services that each industry produces. It does not distinguish between primary and secondary goods and services that an industry produces.[4] These tables are consistent with other economic accounts and industry statistics.[5] The IRDSA provides a similar set of make and use tables as the standard I-O accounts.

The I-O accounts use establishment-based data.[6] They currently identify a portion of establishments' spending on domestic R&D, based on Census Bureau data on establishments classified in two main R&D industries: Scientific Research and Development Services (NAICS 5417),[7] and Management of Companies and Corporations (NAICS 551).[8] The IRDSA does not change this treatment of these industries and commodities.

[4] A second set of supplemental tables is also prepared. These tables redefine products that are not the primary output of an industry to those industries in which they are primary. These supplemental tables are consistent with the I-O theory and convention that follow the principle of homogeneity. The homogeneity principle groups establishments by similarity of production processes, so that each industry is comprised of establishments that have similar production functions, producing outputs with a similar set of inputs. For example, hotels produce both accommodations services and restaurant meals; the primary output of hotels is accommodations services, and their secondary output is restaurant meals. Industry output, after redefinition, is used in the calculation of total requirements tables, and are generally not comparable to other economic accounts statistics.

[5] These tables became the standard or "featured" tables beginning with the 1997 Benchmark I-O accounts.

[6] As do the GDP-by-industry account and fixed assets tables.

[7] This industry is included in a broader sector: Miscellaneous professional, scientific, and technical services, in the GDP-by-industry accounts.

[8] The Census Bureau form for NAICS 5417 collects information for firms that produce scientific research

What is Different?

The IRDSA makes several changes to the standard I-O accounts. First, like the preliminary R&DSA, the IRDSA changes the treatment of R&D purchases by businesses from intermediate consumption to investment. The IRDSA recognizes R&D as an investment whose benefit extends beyond the current production period. Therefore, the current treatment of R&D as intermediate consumption in the I-O accounts must be changed to capture the role of R&D in the production process. Second, the IRDSA defines a second set of commodities under R&D, those produced for the establishment's own use, or own account. Both R&D produced for sale and R&D for own account are treated as investment. Own account R&D can be considered to be "purchased" by its creator as investment, but this imputed purchase does not have a market and price associated with it.[9] Third, the IRDSA also reclassifies R&D expenditures of nonprofits and of general government as investment; the measure of R&D current cost used for valuing output and consumption expenditures is based on consumption of fixed capital for R&D assets rather than on R&D expenditures.

Proposed Framework for the IRDSA

The framework for the IRDSA proposed here represents a model or tool that can be used to examine differences in the R&D activities of establishments in R&D industries

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and development services, and provides a separate section for auxiliaries of firms that conduct R&D. If the R&D production is at a different establishment than the establishment where the headquarters is located, then it should be treated as Auxiliary Scientific Research and Development Services, which is industry 54170A in the standard tables. Other R&D activities that are reported under Management of Companies and Corporations are re-defined in the I-O accounts and are included in NAICS 5417 in the supplemental tables.

[9] The supplemental (after redefinitions) table separates out the primary and secondary output of industries, and re-defines the R&D output of industries, as a secondary output with a different production process from their primary products. In the supplemental table, R&D commodity output (for sale and for own-account) is re-defined as output of the scientific R&D services industry (NAICS 5417).

and differences in impact of R&D in these industries. The proposed IRDSA has five tables: The Make Table (table 1); the Use Table (table 2); the Capital Flow Table (table 3); the Capital Stock Table (table 4); and the Employment and Compensation Table (table 5).

The Make Table

The Make Table (Table 1) accounts for domestic and international production. The table highlights the industry defined as R&D services under NAICS 54 (professional business services). Besides R&D commodities for sale, it also identifies a new commodity under R&D services (5417); that is, R&D services for internal use or own account. The make table shows the details of R&D-related services produced by industries, presenting the details of the R&D commodities produced by an industry, either for sale or for own account. For example, the computer manufacturing industry produces computers as its primary product, and produces a secondary product, computer-related R&D services, for its own use in the computer industry. R&D-related services produced by other industries are treated similarly.

The Make Table follows the change in the treatment of government as producer, a change introduced in the 2003 Comprehensive Revision of the NIPA. This change explicitly recognizes that general government is engaged in the production of services (valued as the expense of providing those services), and treats the purchase of goods and services by general government as intermediate inputs. Services that are directly purchased from government (for example, college education) are treated as secondary products of the government industry, and the remaining services are treated as

Table 1. Make Table

		Industries							Total commodity output at basic prices	Imports	c.i.f adjustment	Total supply at basic prices	Trade and transport margins	Taxes less subsidies including import duties	Total supply at purchasers' prices
		Agriculture, forestry, and fishing	Manufactured products	Information services	Lessors of nonfinancial intangible assets	NAICS 54 - Professional and business services		Government	Other							
						Non-R&D	R&D Services									
Commodities	NAICS 11 - Agriculture, forestry, and fishing														
	NAICS 31-33 Manufactured products														
	NAICS 51 - Information services														
	NAICS 533 - Lessors of nonfinancial intangible assets														
	NAICS 54 - Professional and business services														
	NAICS 5417 - R&D services														
	For sale														
	Own-account[1]														
	NAICS 54 excl 5417 - Non-R&D professional and business services														
	Government														
	Other														
Total industry output at basic prices															

1. The own-account R&D commodity can be split into a number of sub-commodities reflective of those industries producing own-account R&D, such as own-account pharmaceutical R&D, own-account other chemicals R&D, own-account semiconductor manufacturing R&D, etc.

consumption expenditures of government. The IRDSA incorporates this change by including a row for government R&D services in the subset of R&D commodities under 5417 in the Make Table. Treatment of all non-R&D commodities and industries does not change from that in the I-O accounts.

The Use Table

The Use Table (Table 2) shows the consumption of commodities by each industry or final user. The total output of each commodity is equal to the sum of all intermediate uses of the commodity by industry and all sales to final users, or the sum of the row entries. The column entries show the dollar value of each commodity used by each industry and the value-added component of that industry. The total output of each industry is equal to the sum of all intermediate uses of commodities and value added, or the sum of the column entries.

The Use Table provides a detailed industry and commodity picture of the change in treatment of R&D from intermediate inputs for businesses to investment and from consumption to investment for non-profits and general government. The R&D activities that used to be intermediate inputs of businesses are reclassified as R&D commodities that are "purchased" as investment in final uses, regardless of whether it is produced for own use or for sale. These changes increase the estimate of GDP by the value of the R&D output. Reclassifying non-profit R&D and government R&D expenditures from consumption to investment does not change GDP, but the addition of a return (net return plus consumption of fixed capital) to non-profits and government from their R&D investments increases GDP. This return represents the flow of services from the R&D

asset that would not exist if R&D is treated as a consumption item. Total R&D investment by business and private non-profits is included in private fixed investment, and R&D investment by government is included in government investment. Estimates of the consumption of fixed capital (CFC) component of the returns to R&D capital for non-profits and government are included in their respective consumption measures, consistent with the current treatment in the national economic accounts in which CFC is a partial measure of the services that these assets provide.[10] The output of non-profits is divided between investment in R&D (R&D purchases) and PCE. The PCE of non-profits falls by the purchases of R&D now treated as investment, and increases by the addition of CFC of R&D capital. Other categories of final uses do not change; that is, household PCE, non-R&D investment, government expenditures, and net exports do not change from the standard treatment in the I-O accounts.

The Use Table also provides estimates of income (Gross Domestic Income) or Value Added. The Use Table of the IRDSA highlights the value added of R&D-producing and non-R&D-producing industries. The value added portion of the table shows three subcategories of detail: Compensation of employees; gross operating surplus, and taxes on production and imports less subsidies to the primary and secondary outputs of industries. The gross operating surplus includes the net returns to and depreciation of R&D capital for businesses, and depreciation for non-profits and government. The R&D expenditures that are treated in the current industry accounts as intermediate inputs are now included in the business income components of gross

[10] Net returns to assets of non-profits institutions and government are not included in the U.S. national economic accounts.

Table 2. Use Table

		Industries							Final Uses				Total commodity output
		Agriculture, forestry, and fishing	Manufactured products	Information services	Lessors of nonfinancial intangible assets	NAICS 54 - Professional and business services		Government	Other	Personal consumption expenditure	Private fixed investment	net export of goods and services	Government consumption expenditures and gross investment	
						Non-R&D	R&D Services							
Commodities	NAICS 11 - Agriculture, forestry, and fishing													
	NAICS 31-33 Manufactured products													
	NAICS 51 - Information services													
	NAICS 533 - Lessors of nonfinancial intangible assets													
	NAICS 54 - Professional and business services													
	NAICS 5417 - R&D services	Intermediate purchases of R&D commodities (zero)								Final purchases of R&D commodities				R&D commodity output
	For sale													
	Own-account[1]													
	NAICS 54 excl 5417 - Non-R&D professional and business services													
	Government													
	Other													
Value added	Compensation of employees													
	Taxes on production and imports less subsidies													
	Gross operating surplus													
Total Industry Output														

1. The own-account R&D commodity can be split into a number of sub-commodities reflective of those industries producing own-account R&D, such as own-account pharmaceutical R&D, own-account other chemicals R&D, own-account semiconductor manufacturing R&D, etc.

operating surplus of industries; gross operating surplus also includes the services of fixed capital used to create the R&D output.

The net returns to non-profits and government R&D capital and depreciation of their R&D capital are additions to value added when treating R&D as an investment. The value added for non-R&D industries does not change. The Total Industry Output column equals the sum of the intermediate inputs and value added for each industry, R&D and non-R&D industries.

Capital Flow and Stocks Tables

A standard Capital Flow Table shows the structure of flows of new capital goods used by each industry. It presents the destination of new investment in equipment, software, and structures by industries purchasing or leasing the new capital commodity. The IRDSA Capital Flow Table, Table 3, expands the gross private fixed investment component of the I-O use table to show the types of equipment, structures, software, and R&D purchased for use by each industry. Like the standard capital flow table, the capital flow table of the IRDSA is organized in a commodity-by-industry matrix. It modifies the standard table, and adds R&D investment. The IRDSA Capital Flow Table shows how investment, R&D and non-R&D, is allocated to the using industries. Like the Make and Use tables, it shows R&D commodities produced for sale and for own account. Non-R&D investment follows the standard capital flow table.

Table 3 shows five major rows. The first set, R&D Commodities, is divided by R&D for sale and own-account R&D. The second row shows Total industry R&D investment commodities. The third and fourth rows show other investment commodities

Table 3. IRDSA Capital Flow Table

			Industries	Total fixed investment
			R&D 5417 All Other indusries	
			I_1 . . . . . I_N	
R&D commodities	For-sale			
	Own-account	C_1 . . . . . C_N		
	Total own-account			
Total R&D commodities				
Other investment commodities	Software			
	Structures			
	Equipment			
Total other investment commodities				
Total industry use of new equipment, structures, software and R&D				

Table 4. Capital Stocks Table

		Commodities				Industry total	
		R&D		Non-R&D			
		Fixed investment	Cumulative capital stock	Fixed investment	Cumulative capital stock	Total fixed investment	Total cumulative capital stock
		C_1 … … … C_N Total	C_1… … … C_N Total				
Industries	I_1 . . . . I_N						
Commodity total							

– equipment, structures, software – and the total of these investment commodities. The fifth row is the sum of total industry R&D fixed investment and the sum of all other fixed investment. This table may be viewed as a "R&D funders" table[11] because it shows the sources of funds for R&D capital investment, separating R&D commodities by whether the R&D commodity was produced for sale or for own use (own account).

The Capital Stock Table (Table 4) includes gross investment expenditures from the current period and the accumulation over multiple periods to form net capital stocks of equipment, structures, software, and R&D. The R&D Capital Stock table supplements the R&D Capital Flow Table. The R&D Capital Stock Table shows net stocks of R&D capital accumulated across multiple periods in addition to the stock produced in the current period. Net capital stock equals the existing stock less depreciation plus current period gross investment. The table presents estimates of total R&D capital stock and total non-R&D capital stock by industry.

Employment and Compensation Table

The Employment and Compensation Table (Table 5) shows the domestic labor supply used in the production of R&D and the associated labor cost.[12] It presents data by industry and total for all industries on the occupational category of labor used to produce R&D for sale and for own account. Employment and compensation for non-R&D commodities are measured separately.

[11] If the transactions could be classified as sales and as subsidies, this connection as funders would be broken for subsidized R&D.
[12] The tables are presented here in nominal dollars.

Table 5. Employment and Compensation Table

		Employment								Compensation							
		R&D						Non-R&D	Total	R&D						Non-R&D	Total
		For-sale			Own-account					For-sale			Own-account				
		Scientists and engineers	Staff	Total	Scientists and engineers	Staff	Total			Scientists and engineers	Staff	Total	Scientists and engineers	Staff	Total		
Industries /1/	I_1 . . . . . I_N																
Total industries																	

/1/ List of industries includes private business, nonprofit, and government.

Practical Considerations and Empirical Implementation

While this framework provides a model for estimating the IRDSA, its implementation may involve changes in some details. Estimating the IRDSA hinges on development of methodologies and the availability of data to measure R&D commodities produced at the level of detail required. The framework serves as a guide for using available data to provide reasonable first approximations of the R&D investments by industry, nonprofits, and government, and for collecting additional detailed data needed to produce a complete IRDSA. Several methodological issues also need to be addressed to implement the conceptual framework: Adjustment of BEA's annual I- O estimates, GDP-by-industry estimates, and the benchmark I-O estimates to treat R&D as investment; allocation of enterprise-based R&D survey data to the establishments that supply R&D output; and assignment of this output to the establishments that acquire the R&D as investment. In addition, industry prices for R&D output need to be developed. Each of these issues is discussed below, along with data availability issues.

2007 IRDSA: Adjustments of Industry Accounts

For 2007, the IRDSA adjusts the standard I-O accounts to include estimates of R&D output, R&D investment, and detailed price indexes for the R&D output. It provides estimates of R&D investment, nominal R&D output, and nominal value added, detailed price indexes for R&D output, real R&D output, and real value added for detailed industries.

The first step in testing our methodology with available data is analyzing R&D investment for the selected group of fourteen industries: Thirteen detailed industries and one all other industries category for the years 1997 to 2004, using the IRDSA framework. These industries represent the largest business performers of R&D in the domestic economy, and about two-thirds of all industrial R&D expenditures in 2001. These industries are listed in Table 6.

Table 6

Detail Level for Impact on Real Value added, R&D investment and R&D output, and R&D prices, 1997 – 2004	R&D Activity (millions of $)	(% of Total)
ALLX (All other industries)	71,059	35.2
Chemical mfg excluding pharmaceutical mfg (325 excluding 3254)	7,755	3.8
Pharmaceutical and medicine mfg (3254)	10,137	5.0
Computers and peripheral equipment mfg (3341)	3,178	1.6
Communications equipment mfg (3342)	19,019	9.4
Semiconductor mfg (3344)	14,358	7.1
Nav/measuring/medical/control instruments mfg (3345)	12,947	6.4
Other computer and electronic products (other 334)	1,090	0.5
Motor vehicles, trailers and parts mfg (3361-3363)	17,207	8.5
Aerospace products and parts (3364)	7,868	3.9
Other transportation equipment mfg (3365-3369)	890	0.4
Software (5112)	13,111	6.5
Computer systems design and related services (5415)	9,154	4.5
Scientific R&D services (5417)	14,244	7.1

For the group of industries selected, the 2007 IRDSA provides more industry detail than the standard GDP-by-Industry account which gives a 65-industry level of detail. This preliminary set of accounts shows the differences in the current industry

accounts and in the National Income and Product Accounts (NIPAs) that treat R&D as a current expense, and the IRDSA which treats R&D as an investment (R&D for sale and R&D for own-account). It also shows the changes in the level of GDP, fixed investment, private inventories, level of intermediate expenditures, and value added and its components. The impacts on the accounts are discussed in Appendix 1, and Tables A, B, and C highlight these differences for private industry.

What Data Are Available for What Industries

Two sets of data are used to estimate the IRDSA. The first set is from the National Science Foundation (NSF). The NSF collects data at the 3- to 4-digit NAICS level of detail on industry R&D expenditures and R&D employment, wages and salaries, and benefits on an enterprise basis.

The second set is from the Census Bureau. The current, standard I-O accounts explicitly include Scientific R&D services (NAICS 5417) and aggregate R&D expenditures into NAICS 55 the portion of Management of Companies and Enterprises (NAICS 55) undertaking R&D services. Both are collected on an establishment basis. These data are available for Quinquennial Economic Census years, as well as in the Services Annual Survey (SAS).

Allocation of Enterprise-based R&D data

All data on industries from the NSF are collected on an enterprise basis, and a methodology is needed to translate the NSF enterprise-based R&D private industry spending into establishment-based R&D spending. The methodology planned to convert

enterprise data to establishment basis uses an enterprise-establishment employment matrix, using occupational employment data by establishment from the Bureau of Labor Statistics and R&D employment data by enterprise from the NSF. To allocate R&D to establishments, R&D output is assumed to be proportional to R&D-related employment. That is, each employer of scientists and engineers in an establishment outside of NAICS 5417 is assumed to produce its output with the same proportional R&D-related employment as NAICS 5417 establishments. This assumption is applied to each of the industry groups included in the IRDSA.

Establishment-based industry estimates of R&D spending are available for NAICS industry 5417, Scientific Research and Development Services auxiliaries, and are collected by the Census Bureau for Economic Census years (every five years). Although these estimates are less than 20 percent of total estimated total R&D spending in 2002, they provide a basis for evaluating the conversion methodology.

Industry Prices for R&D Output

Real R&D investment, output, and value added are estimated using two different price scenarios. One scenario is based on input prices, estimated with the cost of producing R&D output (similar to Scenario A in the 2006 preliminary R&DSA). Prices for this scenario are created using methods developed in BEA's 1994 and 2005 R&D satellite accounts, and extended to reflect industry-specific costs. The second method developed in the 2007 satellite account is conceptually similar to the Scenario D price index from the 2006 R&DSA. This scenario uses a price index that reflects the output prices of industries that performed the most R&D. This price scenario is based on

products produced with R&D, using producer price indexes from the Bureau of Labor Statistics (BLS).

Other Tables

The Capital Flow Table and the Capital Stock Table are estimated using the Make and the Use Tables to show which industries purchased equipment, structures, software, and R&D investment. The Capital Stock table shows the net stock of R&D capital accumulated across periods. The Employment and Compensation Table uses data from the NSF and the BLS to show the domestic labor and compensation paid to produce R&D commodities.

Technical Appendix

Impact on Production Account from Capitalizing R&D

The industry production account provides a framework for examining differences among industries' investment in R&D and the impact of these investments. Currently, the production costs of private business, including the costs associated with all R&D, are classified as inputs to production with no corresponding output of R&D.[13] The production costs of nonprofit institutions serving households and general government, including the costs associated with all R&D are recorded directly as the value of output by these sectors and, thus, include a measure of output of R&D. In the proposed treatment from capitalizing R&D, GDP will increase by the value of private businesses' output of all R&D, which will be measured by their R&D production costs, plus an imputed net return on the consumption of fixed capital used for R&D (e.g., labs and equipment). For the R&D by nonprofit institutions serving households and by general government, GDP will increase by the imputed net return on the consumption of fixed capital these sectors used for R&D, plus the consumption of fixed capital on their existing capital stock of R&D including an imputed net return on this consumption as well.

Tables A-C illustrate changes to the industry production accounts that result from treating R&D as investment. These tables show the current treatment of R&D as expense; the proposed treatment of R&D as investment; and the differences in the two accounts that result from the new treatment. These tables provide hypothetical numerical

[13] R&D here refers to production for both own-use, so-called "own-account production" and for eventual sale or licensing.

values to illustrate changes to various production account measures for private business, nonprofit institutions serving households, and general government.

Impact on Private Business

For private businesses, capitalizing R&D will increase GDP by the value of the additional industry gross output, which will equal the imputed value of their R&D output, measured as the total costs of producing their R&D, plus an imputed net return on the consumption of fixed capital used for R&D (e.g., labs and equipment).[14] (table A). As a result, value added will increase by the amount of the imputed R&D output for the industry. This increase in value added will be recorded as an increase in the business income component of gross operating surplus of the industry. Depreciation of the existing stock of capitalized R&D will reduce the industry's business income, but this reduction will be offset by the depreciation entry within gross operating surplus.

Table A provides an example of changes to the production account after capitalizing private business R&D. Under the current treatment, $12 in R&D related expenses are recorded – $5 in intermediate inputs of goods and services, $3 in compensation paid to a researcher, and $4 in consumption of fixed capital for the depreciation of the laboratory used by the researcher – with zero output that results from these expenses. As a result, industry value added equals -$5, and can derived as industry gross output ($0) less intermediate inputs ($5), or conversely, as the sum of the three major components of value added, compensation of employees ($3), gross operating surplus (-$8) and taxes less subsidies (assumed zero in this example). After capitalizing

[14] For example, these total costs of production could include intermediate inputs, compensation, and depreciation related to conducting R&D.

R&D, an imputed value of R&D output, equal to the sum of the costs incurred in producing R&D, plus an imputed net return on the consumption of fixed capital used for R&D, is added to the industry's gross output ($14). As a result, value added is increased by $14, from -$5 to $9. This increase in value added is recorded in the industry's gross operating surplus, which increases from -$8 to $6.

Impact on Nonprofit Institutions Serving Households and General Government

Because the output of nonprofit institutions serving households and general government is currently measured as the sum of production costs, the capitalization of R&D will increase GDP by the imputed net return on the consumption of fixed capital these sectors used for R&D, plus the consumption of fixed capital on their existing capital stock of R&D including an imputed net return on this consumption.[15] This increase will also be recorded in these sectors' gross operating surplus, value added, and gross output (tables B and C).

In the domestic income and production account, the R&D output of nonprofit institutions serving households and general government is currently treated as consumption expenditure. After capitalization, the R&D output will be recorded as gross private or government investment, and both personal and government consumption expenditures will be reduced by the value equal to R&D output, net of R&D depreciation and an imputed net return on this depreciation.

[15] In practice, the U.S. industry and domestic production accounts do not include a net rate of return on the consumption of fixed capital of nonprofits serving households or general government.

	Basic data for example	
	Current "Expensed"	Proposed "Capitalized"
Production costs for R&D, total	12	12
Compensation paid researcher	3	3
Consumption of intermediate inputs, R&D	5	5
Consumption of fixed capital, R&D lab & equipment	4	4
Imputed net return on R&D lab & equipment consumed		2
Consumption of existing stock of R&D		1
Imputed net return on existing stock of R&D consumed		0.2

Table A. - Impact of New R&D Treatment on Production Accounts, Private Business

Industry Production Account	Current "Expensed"	Proposed "Capitalized"	Difference
Gross output	**0**	**14**	**14**
R&D production costs, total		**12**	**12**
Imputed net return, R&D lab & equip consumed		**2**	**2**
Less: Intermediate input consumption	**5**	**5**	**0**
Consumption of intermediate inputs, R&D	5	5	0
Equals: Value added	**-5**	**9**	**14**
Compensation of employees	3	3	0
Taxes on production, less subsidies			0
Gross operating surplus	-8	6	14
Consumption of fixed capital	4	5	1
Lab & equipment	4	4	0
Existing stock of R&D		1	1
Business income	-12	1	13
Gross output		14	14
Less: Expenses	12	13	1
Compensation of employees	3	3	0
Consumption of fixed capital	4	5	1
Lab & equipment	4	4	0
Existing stock of R&D		1	1
Consumption of intermediate inputs, R&D	5	5	0

Table B. - Impact of New R&D Treatment on Production Accounts, Nonprofits Serving Households

Industry production account	Current "Expensed"	Proposed "Capitalized"	Difference
Gross output	**12**	**15.2**	**3.2**
Imputed gross output, R&D	12	14	2
R&D production costs, total	12	12	0
Imputed net return, R&D lab & equip consumed		2	2
Consumption of fixed capital, existing stock of R&D		1	1
Imputed net return, existing stock of R&D consumed 1/		0.2	0.2
Less: Intermediate input consumption	**5**	**5**	**0**
Consumption of intermediate inputs, R&D	5	5	0
Equals: Value added	**7**	**10.2**	**3.2**
Compensation of employees	3	3	0
Taxes on production, less subsidies			
Gross operating surplus	4	7.2	3.2
Consumption of fixed capital	4	5	1
Lab & equipment	4	4	0
Existing stock of R&D		1	1
Imputed net return, R&D		2	2
Imputed net return, existing stock of R&D consumed 1/		0.2	0.2

1/ In practice, the U.S. industry and domestic production accounts do not include a net rate of return on the consumption of fixed capital of nonprofits serving households.

Table C. - Impact of New R&D Treatment on Production Accounts, General Government

Industry production account	Current "Expensed"	Proposed "Capitalized"	Difference
Gross output	**12**	**15.2**	**3.2**
Imputed gross output, R&D	12	14	2
R&D production costs, total	12	12	0
Imputed net return, R&D lab & equip consumed		2	2
Consumption of fixed capital, existing stock of R&D		1	1
Imputed net return, existing stock of R&D consumed 1/		0.2	0.2
Less: Intermediate input consumption	**5**	**5**	**0**
Consumption of intermediate inputs, R&D	**5**	**5**	**0**
Equals: Value added	**7**	**10.2**	**3.2**
Compensation of employees	**3**	**3**	**0**
Taxes on production, less subsidies			
Gross operating surplus	**4**	**7.2**	**3.2**
Consumption of fixed capital	**4**	**5**	**1**
Lab & equipment	**4**	**4**	**0**
Existing stock of R&D		**1**	**1**
Imputed net return, R&D		**2**	**2**
Imputed net return, existing stock of R&D consumed 1/		**0.2**	**0.2**

1/ In practice, the U.S. industry and domestic production accounts do not include a net rate of return on the consumption of fixed capital of general government.

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