BEA BRIEFING

Toward Better Measurement of Innovation and Intangibles

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WHILE all countries account for investment in tangible assets in their gross domestic product (GDP) statistics, no country currently includes a comprehensive estimate of business investment in intangible assets in their official accounts. Most economists agree, however, that intangible assets—which represent an important input into the innovative process—are critical components of the modern economy. In the United States, some have suggested that investment in intangible assets now roughly equals investment in tangible assets.

Understanding the role of intangible assets—and thus the role of innovative activity in general—is critical to understanding the modern economy. This article updates the ongoing efforts at the Bureau of Economic Analysis (BEA) to better measure investment in various intangible assets.

BEA has a history of continuously improving its GDP statistics to account for major shifts in the economy (chart 1). Indeed, some intangible investments are already included in the GDP accounts. Expenditures on software, for example, have been treated as investment in the core accounts since 1999. And in 2006, BEA launched a research and development (R&D) satellite account, to explore investment in R&D and its larger economic effects.

BEA is currently exploring the feasibility of creating satellite accounts that would report investment in a variety of other intangible assets. Although there are thorny conceptual issues to consider, the binding constraint on progress remains measurement, which is extremely difficult because of the paucity of source data and lack of firm evidence supporting the assumptions required for measurement.

A satellite account refers to a set of accounts that allows for experimental measurement in a framework consistent with GDP but separate from the official accounts. Satellite accounts typically allow for a more detailed look at specific parts of the economy, measures based on new methodologies and source data, and new estimation approaches. The R&D satellite account, for example, provided a means of exploring the impact of capitalizing R&D spending on GDP growth and a framework through which various methodological and conceptual issues can be worked out.

As of now, BEA's main efforts to measure innovative activity have focused on its R&D account, which was produced in partnership with the National Science Foundation (NSF). The most recent version of the R&D account, released in 2007, provides statistics for 1959–2004 on R&D investment and the impact of treating R&D as investment on GDP statistics and other aggregates. The account was also expanded to include detail about the effects on BEA's industry, regional, and international accounts. In the satellite account where R&D is properly treated as investment, investments in R&D contribute approximately 0.2 percentage point to the 3.3 percent growth rate of GDP in 1995–2004.[1]

Although budget reductions prevented the provision of updated statistics in 2008, BEA has continued the necessary research to incorporate R&D investment into core GDP accounts in 2013.[2] Methodological issues still remain. Estimates of real investment in R&D require the use of a deflator, and there is not yet a consensus on how to construct this deflator. BEA is conducting research and hopes to work with the Bureau of Labor Statistics (BLS) on this issue in the future; BEA is also exploring improved measures of depreciation for the R&D stock.

In addition to R&D, investment in artistic originals—mainly motion picture and sound recordings—is scheduled to be incorporated into the GDP accounts in 2013.

Currently, there are no plans to include investment in any other types of intangible assets in the core accounts. However, BEA will continue to work with the NSF in its efforts to expand the NSF survey beyond technological innovation and R&D and to explore the potential impact on macroeconomic aggregates of treating these other asset classes as investment. Beyond

1. For more information on BEA's satellite account for R&D, see Robbins and Moylan (2007) and the documentation provided on the BEA Web site: www.bea.gov/industry/index.htm#satellite.

2. For the first time, the 2008 *System of National Accounts* recommends treating R&D expenditures as investment. The following intellectual property expenditures are also treated as investment: mineral exploration and evaluation; computer software; databases; entertainment, literary and artistic originals; and other intellectual property products.

properly accounting for firms' investments in intangible assets—the subject of this article—BEA is also exploring measures of individuals' investments in human capital—another type of intangible asset. (See the box "Measuring Human Capital.")

The rest of this article discusses the following:

- The conceptual issues surrounding the measurement of innovation and firms' investments in intangible assets
- The logic underlying the national accounting methods used to measure investment
- The different types of intangible assets considered in the literature, including technological and nontechnological innovative assets
- The existing data available for measurement and other measurement challenges
- Details on BEA's plans

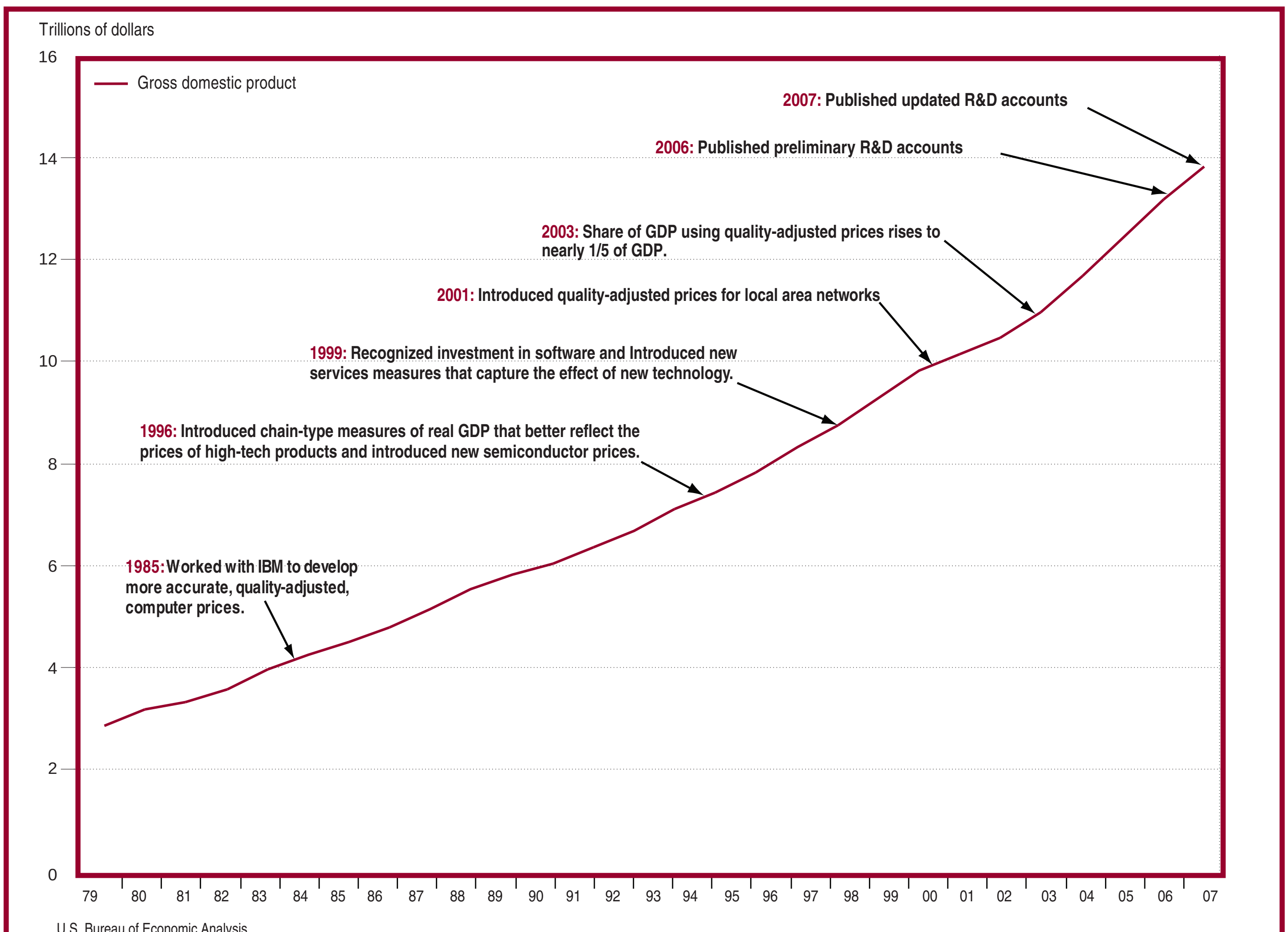
Innovation and Economic Growth

Innovation has long been recognized as an important driver of economic growth. For example, the invention of the transistor over 50 years ago gave rise to wave after wave of new goods that have transformed the economy. Entirely new products, like the semiconductor, and new ways of approaching markets, like the Internet, are examples of the fruits of innovative activities that followed from the development of the transistor.

The notion of "innovation" can be elusive, as seen in the widely different definitions that economists, policy analysts, and business leaders frequently use (see the box "What Is Innovation?" on page 14). Common to these definitions, however, is the realization of commercial value in the market place from the creation of something that did not previously exist. In January of last year, the Commerce Department's Advisory Committee on Measuring Innovation in the 21st Century Economy published a report *Innovation Measurement: Tracking the State of Innovation in the American Economy* that included a definition consistent with the above notion:

> The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of

Chart 1. A History of Progress at BEA



U.S. Bureau of Economic Analysis

creating new value for customers and financial returns for the firm.

While this view of innovation recognizes the importance of both technological and nontechnological innovation, until recently, economic studies on innovation were primarily focused on technological innovation. Examples of this focus include studying the transformation of R&D expenditures into patents and the diffusion of technology across the economy through the adoption of new products or processes, such as a new hybrid seed stock or a new generation of information technology equipment.[3] The emphasis has only recently begun shifting to include the role of new products, processes, and business models in the increasingly important and growing service sector of the economy.[4]

The microeconomic literature has not given rise to a paradigm that lends itself to measuring innovation and its impact on economic growth. Modeling these activities at a microlevel is difficult, in part because the process of innovation involves a complex set of economic actors and interactions that in principle require that one take account of networks, linkages, and complementarities.[5] For example, Stephen Kline and Nathan Rosenberg (1986) have argued that a linear model—in which research expenditures lead to product development and then commercialization—is not an accurate model for the innovation process; this narrow focus on the formal research process misses the feedback between innovators, their competitors, and their customers. A more fundamental problem is that traditional microeconomic theory and measurement are often based on the presumption that change is incremental, while innovation by its nature creates not only incremental improvements but also completely new products, processes and markets.[6]

In contrast, macroeconomists and national accountants take a more stylized view of the economy and use a "residual" method to understand the overall contribution of innovation to economic growth. As Robert Solow (1957) noted, most of the growth in gross national product could not be explained by growth in conventional inputs, such as (tangible) capital and labor. He attributed most of the unexplained residual in economic growth to "advances in knowledge." This observation helped fuel over 40 years of conceptual and empirical research into the sources of economic growth. Researchers such as Denison (1962) and Jorgenson and Griliches (1967) built growth accounting models that provided a conceptual and accounting framework for explaining the sources of growth with a special emphasis on accounting for the unexplained residual, also called multifactor productivity (chart 2). Using this metric, less than half of the growth in the economy today can be attributed to growth of the traditional inputs, labor and capital. The residual can also be attributed to mismeasurement of labor and capital inputs and to the effects of any spillovers—benefits of

Measuring Human Capital

Building on work that BEA has done in the measurement of education and earlier work by Jorgenson and Fraumeni (1992) and others, BEA is conducting research to measure individuals' investments in human capital. The importance of human capital as a source of growth has long been recognized: "Separate education accounts would contain data essential for improving our understanding of how investment and the capital stock, defined more broadly to include both human and nonhuman capital, affect economic growth" (National Research Council 2005). This initiative would provide statistics with which to track the stock of human capital, the rate at which the stock depreciates, and the returns to investments. This information is important for tracking and managing one of the nation's most important assets that represents an important input into the innovation process.

The measure currently under consideration differs in several respects from that used in Corrado, Hulten, and Sichel (2006). First, BEA will only measure investments in traditional education, not on-the-job training. Although this would miss an important type of investment that firms make in their workers, the measurement of investment by firms in their workers' human capital is relatively new, and the data sources are sparse. In contrast, the theory underlying the measurement of individuals' investments in their human capital dates back many years, and the needed data are available. Second, to remain within the scope of national accounting standards, BEA will focus on market-based activity and will only measure market-based investments in education, not individuals' investments in time.

3. See Griliches' (1957) classic work on hybrid corn and Fichman (1992), who provides an early survey of the literature on the diffusion of information technology.

4. "Innovation in Services" in Miles (2004) and "Supporting Innovation in Services," United Kingdom Department for Business, Enterprise, and Regulatory Reform (2008).

5. For example, it is commonly understood that innovation is influenced not only by the actions of a particular firm but also by the institutional environment, the structure of the production process, the other firms and customers that the firm interacts with, the public research infrastructure, and the characteristics of the labor market (Fagerberg 2004).

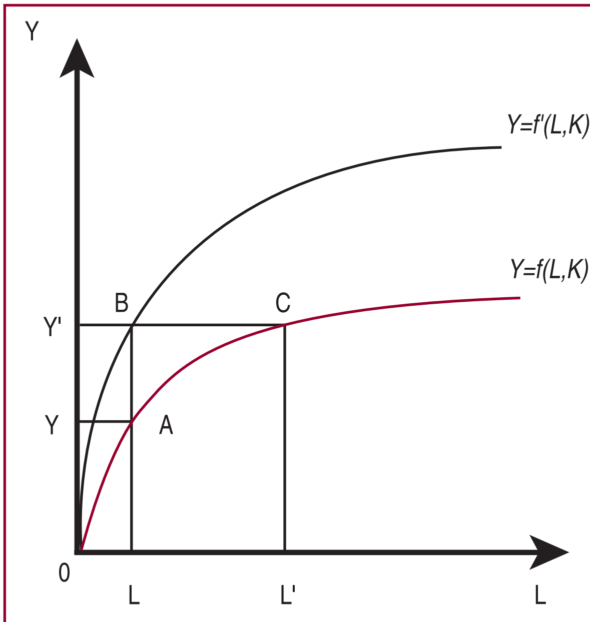
6. Indeed, Alfred Marshall's preface to *Principles of Economics* (1946), "Natura non facit saltum," or "nature does not make leaps," is at odds with the views of many economists who study innovation.

innovative activity above what an economic entity has paid for; because they are not paid for directly, spillovers lie outside the scope of firm-supplied inputs to production and will be captured in the residual.

Much of the recent work by macroeconomists in this area has concentrated on identifying and measuring inputs other than tangible capital and labor that are related to innovation and can contribute significantly to growth. In particular, one focus has been on investments in intangible assets. A paper by Leonard Nakamura (1999) and a series of papers by Corrado, Hulten, and Sichel (2004, 2006) has shown that under a plausible set of assumptions, the measured contribution of intangible assets to economic growth could be substantial. Their results for the United States have been replicated for other countries, and there is now a growing consensus on the importance of these assets in accounting for economic growth.

Summing up, the innovation process leads to the creation of economically useful knowledge that exists separately from either people or tangibles, such as equipment or structures. This economically useful knowledge is an intangible that is an output of a productive process as well as an input into the creation of new output. By identifying measures of this knowledge, measuring them using national accounting, and incorporating them into a growth-accounting framework, one can begin to develop a comprehensive set of statistics to better understand innovation as a driver of economic growth.

Chart 2. Simple Sources of Growth Model: Interpreting Multifactor Productivity



NOTE. This figure illustrates two ways an economy can increase its output. The chart shows two simple production functions with inputs of labor (L), which differs between points B and C, and capital (K), which remains fixed. Each production function demonstrates the level of output (Y) that can be obtained from combinations of inputs. At point A, the economy uses the production f(L,K) to produce output level, Y. By changing its production process, an economy can shift to f '(L,K) using the same level of labor, moving to point B, where it produces a higher level of output, Y'. Alternatively, the economy can use the original production function, f(L,K), but increase labor input to achieve Y' at point C; this results in the same level of output produced at point B. In the traditional sources of growth model, the residual would include the increase in output from point A to point B or would be interpreted as multifactor productivity.

Measuring Intangibles in the National Accounts

As demonstrated by Corrado, Hulten, and Sichel, accounting for intangible assets in the national accounts and in the Solow growth calculation can be done using the same method that is currently used for tangible assets. That method is summarized in this section.

Essentially, treating spending on intangibles as investment would have two primary effects on the national income and product accounts: it would increase GDP and gross domestic income (GDI) in periods when firms invest in intangibles. It would also add a new input—intangible capital or "the stock of knowledge"—and the value of the capital services generated by that capital would be measured in the income account in subsequent periods.

Table 1 shows the consolidated income and product accounts for the United States: the right, or "product," side of this account shows the total final output produced in the nation organized by type of expenditure, and the left, or "income," side shows the incomes earned and other costs incurred in production.

The summary measure of production on the right side—GDP—is defined as the market value of final goods and services produced by labor and property within the United States during a given period. The product entries show the approach used by BEA to derive GDP: it is measured as the sum of purchases by final users—and includes the familiar spending categories of consumption, investment (including inventories), and net trade.

Gross private domestic investment includes purchases of fixed assets (equipment, software, and structures) by private businesses and nonprofit institutions serving households that contribute to production and have a useful life of more than 1 year. It also includes construction of housing for households and private business investment in inventories. Importantly, intermediate inputs, which are entirely used in the production process in one period and do not contribute to future production, are not included in investment.

On the left is the sum of all the incomes earned and costs incurred in production. Specifically, the left side shows GDI as the sum of the income earned by labor (compensation of employees), by governments (taxes on production and imports less subsidies), and by entrepreneurs (net operating surplus, which is a profits-like measure for private and government enterprises), and the consumption of fixed capital (the using up of capital).

To trace through how investment is recorded in the accounts, suppose a firm purchases a new productive

Table 1. Domestic Income and Product Account, 2007

[Billions of dollars]

Line			Line		
1	Compensation of employees, paid	7,819.4	15	Personal consumption expenditures (3–3)	9,710.2
2	Wage and salary accruals	6,362.8	16	Durable goods	1,082.8
3	Disbursements (3–12 and 5–11)	6,369.0	17	Nondurable goods	2,833.0
4	Wage accruals less disbursements (4–9 and 6–11)	–6.3	18	Services	5,794.4
5	Supplements to wages and salaries (3–14)	1,456.6	19	Gross private domestic investment	2,130.4
6	Taxes on production and imports (4–16)	1,015.5	20	Fixed investment (6–2)	2,134.0
7	*Less:* Subsidies (4–8)	52.3	21	Nonresidential	1,503.8
8	Net operating surplus	3,386.0	22	Structures	480.3
9	Private enterprises (2–19)	3,393.9	23	Equipment and software	1,023.5
10	Current surplus of government enterprises (4–26)	–7.9	24	Residential	630.2
11	Consumption of fixed capital (6–13)	1,720.5	25	Change in private inventories (6–4)	–3.6
			26	Net exports of goods and services	–707.8
12	**Gross domestic income**	**13,889.0**	27	Exports (5–1)	1,662.4
			28	Imports (5–9)	2,370.2
13	Statistical discrepancy (6–19)	–81.4	29	Government consumption expenditures and gross investment (4–1 and 6–3)	2,674.8
			30	Federal	979.3
			31	National defense	662.2
			32	Nondefense	317.1
			33	State and local	1,695.5
14	**GROSS DOMESTIC PRODUCT**	**13,807.5**	34	**GROSS DOMESTIC PRODUCT**	**13,807.5**

What is Innovation?

The following definitions of innovation vary, but the common thread is the extraction of economic value from novel activities (Innovation Vital Signs Project 2007).

Innovation is “the commercial or industrial application of something new—a new product, process or method of production; a new market or sources of supply; a new form of commercial business or financial organization.”

Schumpeter 1983

Innovation is the “intersection of invention and insight, leading to the creation of social and economic value.”

Council on Competitiveness 2005

Innovation covers a wide range of activities to improve firm performance, including the implementation of a new or significantly improved product, service, distribution process, manufacturing process, marketing method or organizational method.

European Commission 2004

Innovation—the blend of invention, insight and entrepreneurship that launches growth industries, generates new value and creates high value jobs.

Business Council of New York State 2006

The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational models for the purpose of creating new value for customers and financial returns for the firm.

Advisory Committee on Measuring Innovation in the 21st Century Economy, Department of Commerce 2008

An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. Innovation activities are all scientific, technological, organizational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations.

OECD 2005

Innovation success is the degree to which value is created for customers through enterprises that transform new knowledge and technologies into profitable products and services for national and global markets. A high rate of innovation in turn contributes to more market creation, economic growth, job creation, wealth and a higher standard of living.

Innovation Vital Signs Project 2007

asset that was created in the same period.[7] This purchase affects the national accounts both in the period when it is purchased and in subsequent periods as the asset provides services to the firm. Because the asset is a final good, its value is recorded as investment and adds to GDP in the period that the asset is produced. The value of the asset may be thought of as the expected discounted present value of the stream of benefits it will provide into the future. Offsetting this entry, the costs of producing the asset—payments to factors of production—are recorded on the income side of the account. Once purchased, the asset becomes an input to the production process, and the flow of services to the production of other goods and services from the asset in each period of its service life is recorded in the income account. This flow of services may be thought of as the amount that producers would be willing to pay to rent the asset for a given period. In principle, the sum of all the rental payments would equal the value and, hence, the price of the asset.

In practice, national accountants use the notion of a capital stock to deal with the intertemporal nature of these capital assets. The perpetual inventory method is used to construct capital stocks that track the value of assets in an asset account separate from the GDP accounts. In the fixed assets accounts, investments are added to the capital stock in the period when they are made, and depreciation is used to measure reductions in the capital stock. The value of capital services—the value of the assets' use in production, similar to the rental payments described above—is defined as the sum of depreciation and the net return on investment. Depreciation (or consumption of fixed capital) provides a measure of how much of the asset is "used up" in production. This per period value reflects an amount that would need to be set aside to eventually replace the asset as it is used up in the production process. The net return on investment recognizes that the asset contributes to the profitability of the company. In the business sector, net returns are assumed to be included implicitly in the measure of net operating surplus in the income account.[8]

In the Solow (1957) growth model, recognizing these intangibles as investment would increase the value of output—real GDP—and of inputs—the value of services from the new input. While this, in principle, could increase or decrease the Solow residual, empirical studies typically show reductions in the size of the residual when the treatment of intangible inputs is changed from an intermediate good to an investment good.

The construction of these national accounting measures requires data on nominal spending to measure investment, price deflators to translate nominal investment into real quantities, and several parameters for the construction of the capital stocks and services from that stock, notably depreciation rates.

Identifying and Measuring Nominal Spending on Intangibles

This section discusses the broad classes of spending that have been considered intangible assets in previous studies with a focus on two major issues.[9] The first issue concerns the types of spending that can be considered investment. This issue hinges on the length of assets' service lives; goods that are treated as investment goods in the national accounts typically have services lives longer than 1 year. The second issue concerns the data available to construct these measures, an important issue because existing studies suggest that the choice of which spending to treat as investment is often guided by data availability and quality issues rather than by conceptual issues about which types of spending constitute investment.

Table 2 provides a list of spending classes that Corrado, Hulten, and Sichel (2004, 2006) explored and their estimates of these expenditures.

Table 2. Business Spending on Intangibles, 1998–2000

[As a percent of gross domestic product]

Total intangible expenditures as a percent of gross domestic product	**13.2**
Computerized information software and databases	**1.7**
Innovative property	**4.6**
Research and development, including social sciences and humanities	2.9
Mineral exploration and evaluation	0.2
Other innovative property	
Copyright and license costs	0.8
New architectural and engineering designs	0.7
Economic competencies	**6.9**
Brand equity	
Advertising expenditures	2.3
Market research	0.2
Firm specific human capital	
Direct firm expenses	0.2
Wage and salary costs of employee time	1.0
Organizational structure	
Purchased	0.9
Own account	2.3

Source: Corrado, Hulten, and Sichel 2004.

7. This section explains how a new investment is recorded in the accounts over its service life. For an explanation of how changing the accounting treatment of spending on intangible assets from an expense on an intermediate good to investment, see the box "How R&D Investment Affects GDP and GDI" in Robbins and Moylan (2007).

8. The inclusion in the R&D satellite account of net returns to nonprofits and general government is a departure from BEA's current calculation of GDI, which includes only depreciation, a partial measure of capital services. In the current GDP accounts, governments do not earn profits, so only depreciation is counted.

9. See Corrado, Hulten, and Sichel (2004) for a fuller discussion of these issues and the measurement difficulties.

Computerized information

Information contained in software and databases is a significant knowledge asset that can be an important contributor to the innovation process and thus economic growth. Expenditures for these types of intangible assets are perhaps the easiest to measure, and indeed many of these expenditures are already treated as investment in GDP.

Notably, BEA has treated business and government expenditures for computer software as investment since 1999. The relative accessibility of data sources for computerized information allows a fairly detailed and comprehensive estimate for nominal investment in software. Purchases of software by businesses and government, either prepackaged or custom, are derived by first forming estimates of domestic absorption of software and then removing software purchases by households, software embedded in computer equipment, and changes in inventories.

The source data for these calculations include the Census Bureau Service Annual Survey, Census Bureau data on trade in goods, financial statements for original equipment manufacturers, and input-output relationships. Investment in own-account software—software produced internally by firms—is measured as the sum of production costs, primarily based on information on employment and wages from the BLS Occupational Employment Statistics Survey.

Expenditures on computerized databases have typically not been estimated separately in the literature. According to estimates from the Service Annual Survey, databases purchased externally appear to be small relative to overall spending by firms on software. Databases that are produced internally are thought to be already captured in the software estimates (custom and own-account).

Innovative property

Expenditures for technological and creative property are larger than those for computerized information, representing about a third of total spending on intangible assets, according to the Corrado, Hulten, and Sichel estimates. These assets are mostly the output of R&D but also include creative property, such as the development of new motion picture films and other forms of entertainment and, more broadly, nontechnological spending for new product development.[10]

The portion of spending on innovative property that involves technological R&D, which accounts for about half of the business spending in this class, is currently measured in the BEA R&D satellite account. Comprehensive measures for R&D were facilitated by a long time series of data on R&D spending provided by the NSF. For technological activity, the NSF data on R&D expenditures and federal government outlays and obligations for R&D allow the measurement of R&D performed by private business, private nonprofit institutions serving households, and government entities. Data on R&D performed by others at the government's expense and data on R&D performed by the government for its own use are both available.[11]

A portion of social science-related R&D, or nontechnological R&D, is also measured in the account. BEA measures for the nontechnological piece of R&D investment are less comprehensive but do include estimates for (1) the sale of social science R&D by private business based on economic census data, (2) the performance of social science R&D by federal government labs, and (3) the performance of social science and humanities-related R&D by academic institutions. The latter two estimates are based on data from the NSF survey.[12]

Among other types of innovative property, mineral exploration, a relatively small component, is currently treated as investment in the GDP accounts, based on data from the Census Bureau. A related category of creative property—entertainment, literary, or artistic originals—includes spending to create musical scores, films, musical recordings, and artistic images. Research is currently underway at BEA to develop methodologies and data sources to incorporate film originals and sound recordings into the GDP accounts.[13]

With regard to other categories of innovative property, data sources tend to be scarce. Existing studies have therefore tended to use proxies that assume the growth rates in spending track some indicator series. For example, Corrado, Hulten, and Sichel estimate new product development costs for finance and other

10. BEA considers the scope of R&D investment to include both technological and nontechnological activity as long as the purpose is to increase the stock of knowledge, including knowledge of man, culture, and society that is used to devise new applications. This definition of R&D is from the Organisation of Economic Co-operation and Development (2002, 30, paragraph 63). BEA considers R&D in the social sciences and the humanities to be nontechnological R&D.

11. These measures of R&D investment are based on R&D expenditures, which implicitly treat both failed and successful activity as capital forming. R&D expenditures are adjusted to prevent double-counting with other forms of capital formation, deflated with a price index for R&D output, and cumulated into stocks with the perpetual inventory method.

12. The limitation for business-performed R&D is that the current NSF source data only include the activity of people who are trained in engineering or in the physical, biological, mathematical, statistical, or computer sciences. Some activities were specifically excluded: market research, sales promotion, sales service, and other nontechnological activities, including research in the social sciences or psychology (National Science Foundation 2006). The NSF's new survey will specifically include social science R&D.

13. See Soloveichik (2008).

services industries as some percentage of intermediate purchases by those industries.

The NSF and Census Bureau are currently working to expand the existing Business Research and Development Survey, an important effort that will help fill the gaps in existing data sources. NSF announced a new Business R&D and Innovation Survey (BRDIS) developed jointly with Census Bureau (Wolfe 2008). The initial BRDIS questionnaire will be launched in January 2009. It will collect data for 2008, and this initial cycle will serve as a full-scale pilot for the new annual survey.

In addition, NSF's Science of Science and Innovation Policy program is funding research to better understand the microfoundations of innovation and innovation ecosystems through the development of models, tools, metrics, and data. The program is also investing in the development of a research database to study knowledge generation and innovation within organizations.

Economic competencies

Economic competencies is the largest category in the Corrado, Hulten, and Sichel framework, making up about half of the spending shown in table 2. This category of spending presents both conceptual and specific measurement challenges.

Brand equity. Advertising and marketing spending that is aimed at the development of brands and trademarks may be considered investment in an intangible asset. While accountants have long recognized the value in a trade name, or "brand," to individual firms, there are conceptual issues about whether this type of asset to a firm should be treated as investment in a national account. First, some argue that advertising and marketing expenditures are in some sense unproductive, perhaps because advertising and brand equity are thought to affect the demand function instead of the production function. In contrast, spending on other intangibles directly affect the production function by either creating a better output or the same output using fewer inputs or better inputs. This issue is contentious, however; Hulten and Hao (2008) argue in favor of treating this type of spending as investment.

A separate issue is that cumulating advertising expenditures may increase a firm's output, but it does not follow that cumulating all firms' advertising expenditures increases aggregate output. Therefore, there is potentially a fallacy of composition problem involved in capitalizing these expenditures in the national accounts and calling them part of an aggregate capital stock.[14]

Finally, a measurement issue discussed in Corrado, Hulten, and Sichel (2006) is that reported expenditures on advertising and marketing typically include both expenditures on brand equity—a long-lived asset—and expenditures for other types of advertising. Corrado, Hulten, and Sichel (2006) estimate that about 60 percent of the reported expenditures for advertising and marketing are devoted to developing brand equity and, as such, may be considered investment.

Other assets. Other economic competencies represent spending that affects either the inputs, such as human capital, or the production function, such as organizational change, and are more likely to have long-lived effects.

On-the-job training and other types of education improve the quality of the workforce and likely improve productivity. Moreover, many economists believe that the quality of the workforce is a critical component not just to growth but to innovation as well.[15] With regard to data sources, firms' investments in the human capital of their workers appear to be the easiest to measure but represent a relatively small piece of spending on economic competencies. Even here, a full accounting of this human capital would also include an estimate of the wage and salary costs of employee time, a component that Corrado, Hulten, and Sichel estimated to be much larger than direct firm expenses.

Spending on organizational change—an asset that includes, for example, spending on business models like improved inventory and distribution systems—is more difficult to measure because there is no broad consensus on the scope of these assets and little hard data with which to measure the spending.[16] The portion of organizational capital that is purchased can be estimated using data on the revenues of management consulting companies. However, a substantial portion of these activities are handled in-house and there are no available data on these activities. Existing studies tend to estimate the value of the own-account

14. However, for those interested in competitiveness across national borders, which is a relative concept, it may be valid to say that U.S. firms' brand equity can increase aggregate U.S. output at the expense of India or Europe. When we consider global GDP, the composition problem reemerges.

15. In Aghion and Howitt's (1992) endogenous growth model, for example, the average growth rate is a function of the size of the skilled labor force.

16. Examples of this type of innovation are organizational structure changes, major strategic partnerships, shared services, alternative financing or investment vehicles, divestitures and spin-offs, and the use of a third party operating utility. This description is drawn from IBM Global Business Services (2006).

component by making an assumption about the percentage of management's time that is devoted to these activities.

Translating Nominal Spending into Real Spending, Capital Stocks, and Capital Services

As mentioned above, obtaining measures for nominal spending by businesses on intangibles is only the first step in measurement. Some additional assumptions are required that pose a separate set of challenges. First, the value of investment must be translated into real investment; that is, the influence of inflation must be removed so that one is conceptually left with "quantities" of the asset. Second, as is the case with tangible assets, constructing a stock of these knowledge assets requires assumptions about depreciation rates or service lives. Third, estimating the value of services provided by the asset requires the construction of a user cost.

Deflators

Ideally, one would want a price deflator that allows one to break out any changes in the dollar value of investment in these assets into price and quantity components. There are both conceptual and practical difficulties in constructing these price indexes for services that are even more difficult for intangibles, which are often created by firms for internal use only.

Within computerized information in the current GDP accounts, the value of software is deflated using price indexes from BLS. Specifically, the BLS producer price index (PPI) for prepackaged software is used to deflate prepackaged software, and a composite of the BLS employment cost index and the PPI for prepackaged software is used to deflate own-account and custom software. The indexes for own-account and custom software combine indexes of the likely employment costs to generate the software and measures for potential quality improvements in the software—implicitly measured in the PPI for prepackaged software.

In contrast, in the 2006 and 2007 versions of the BEA satellite account, business investment in R&D is deflated using price indexes for R&D output based on the output prices of the goods produced; spending by government and other nonmarket entities is deflated using input prices. Previous work at BEA has demonstrated that the choice of deflator matters; Okubo and others (2006) show that different output deflators can yield very different measures of real R&D output.

For broader classes of intangibles, a common solution for measuring the outputs of service industries has been to develop a price index for the costs involved in producing the asset—such as wages of engineers and scientists. However, it is well known that this ignores any productivity gains in the production of the asset. An alternative that has been used in some recent studies is the deflator associated with the final industry or the economy as a whole. The idea is that if one can't measure a price index for the intangible, the next best thing might be to use a price index for the good that embodies that intangible asset.

Table 3 summarizes the types of deflators that have been used in recent studies on intangibles. For the most part, studies have used output deflators either at the major sector level (Corrado, Hulten, and Sichel 2006; Marrano, Haskel, and Wallis 2007) or at the industry level (Fukao and others 2007). Some countries continue to use input price indexes; Statistics Netherlands uses these price indexes for some assets (van Rooijen-Horsten and others 2008). The use of these broad output price indexes is a testament to the difficulty in obtaining more accurate deflators. Corrado, Hulten, and Sichel recognize this when they stated that their choice of deflator was a plausible placeholder until further research permits better measures.

User cost and depreciation

Constructing the capital stock and the flow of services from that stock requires assumptions about

Table 3. Major Assumptions in Growth-Accounting Studies of Intangible Assets

Study	Country	Deflator used for new assets	Depreciation rates			
			Computerized information	Innovative property	Economic competencies	
					Advertising	Other
Corrado, Hulten, and Sichel 2006	United States	Nonfarm business output deflator	33	20	60	40
Marrano, Haskel, and Wallis 2007	The United Kingdom	Implied market sector gross value-added deflator	33	20	60	40
Fukao, et al. 2007	Japan	Industry-level deflators	33	20	60	40
van Rooijen-Horsten, et al. 2008	The Netherlands	Combination of input and output deflators	30	20	60	40
Jalava, Aulin-Ahmavaara, and Alanen 2007	Finland	National account and implicit investment deflators	42	22	69	(1)
Baldwin, et al. 2008	Canada	Gross domestic product deflator for business sector	(2)	(2)	(2)	(2)

1. The rate is 18 percent for firm-specific human capital and 33 percent for organizational structures.
2. A range of rates was used: 25, 50, and 75 percent.

depreciation rates and a “rental cost” for the use of the asset, which is typically measured using a user cost formula. Under commonly used methods of constructing user costs, the only element that is specific to the asset is the depreciation rate. Therefore, the primary measurement difficulty in constructing a user cost has to do with the depreciation rate. For intangibles, these depreciation rates are particularly difficult to measure because the depreciation is often related to obsolescence, which can vary immensely across intangible assets, rather than physical decay and wear and tear, a more readily observable phenomena.

Ideally, one would have evidence from microeconomic studies to measure the decay of capital stocks. Usually, however, depreciation rates for these intangibles are necessarily based on assumptions guided by limited evidence. The service lives for software, for example, are based on some indirect quantitative estimates of the relationships between computer expenditures and software expenditures, anecdotal evidence (including an informal survey of business use of software previously conducted by BEA about how long software is used before it is replaced), and tax-law-based lives of software.

In the R&D satellite account, the choices of service life assumptions were based primarily on econometric studies of R&D depreciation and vary by industry. The R&D stock used by the transportation equipment manufacturing industry is assumed to depreciate at 18 percent per year, computer and electronic manufacturing R&D investment at 16.5 percent per year, chemical manufacturing R&D at 11 percent per year, and all other R&D stock at 15 percent per year. Assuming a declining balance rate of 1.7, this implies a mean service life that ranges from $9^1/_2$ years for transportation equipment-related R&D assets to $15^1/_2$ years for chemical-related R&D assets.[17]

In contrast, relatively little is known about depreciation rates and profiles for the other intangible assets. The right column of table 3 gives the depreciation rates that have been used in existing studies. Most of these studies have followed the assumptions made in Corrado, Hulten, and Sichel. For computerized information, they used the depreciation rate that BEA uses for custom software. For innovative property, Corrado, Hulten and Sichel used the midpoint of a range of depreciation rates used for R&D (0.12 to 0.29). The estimated depreciation rate for brand equity is set faster than other assets to allow for the possibility that these assets are relatively short lived. Finally, for other economic competencies, they used the average of the depreciation rates for R&D and brand equity.

The scant evidence on the sensitivity of these estimates to choices of depreciation rates suggests that at least some of the measures of interest are not sensitive to the choice of depreciation rate. For example, Marrano, Haskel, and Wallis (2007) conclude that their calculated multifactor productivity rates were not very sensitive to large changes in depreciation rates. Similarly, Baldwin and others’ (2008) study for Canada also explored different depreciation rates and found that the relative importance of intangible to tangible capital was not sensitive to the choice of depreciation rates.

Summing up, properly accounting for investments in intangible assets poses difficult measurement challenges. For some assets, there is sufficient information with which to construct estimates, and BEA either includes the asset in the national accounts—for example, software—or plans to include them in the future—R&D. Research on data sources and methods is needed to properly measure the other types of intangibles. Indeed, there are several government initiatives to explore new surveys and other data sources in order to improve measures of innovative activities (see table 4).

BEA’s Plans

In addition to incorporating R&D spending as investment into its core accounts in 2013, BEA is considering an expanded satellite account that would contain experimental statistics for a broader array of intangible assets alongside our existing measures for R&D.

In order to develop comprehensive statistics on investment in innovation and intangibles, expanded survey data will be needed to augment the high quality data currently available from NSF. Expanded collection of the data for nontechnological innovative expenditures is a high priority for augmented innovation statistics. Three key areas are spending for the development of new business models, the creation of artistic and literary originals, and spending for the design of new products that is not currently captured by existing surveys. Current work by the NSF and the Census Bureau to expand the existing Business Research and Development Survey is an important step in this direction, and BEA hopes to continue to work with these agencies to develop survey instruments to measure spending on intangible assets.

BEA also plans to conduct research on the measurement issues involved in translating these expenditures on intangibles into their impacts on GDP. As discussed above, two important areas are the development of appropriate output price indexes for each type

17. The declining balance rate reflects a difference in the depreciation rate in the early years of an asset’s life relative to later years. When the declining balance rate is 1, an asset depreciates the same amount in each year of its life. When the declining balance rate is 2, the asset depreciates twice as quickly in the first year of its life, compared with the straight line depreciation. The 1.7 rate is used in BEA’s capital stock measures for producers equipment and software.

of intangible and depreciation measures.

This work on measuring spending on intangibles as investment is part of BEA's overall efforts to modernize the national accounts, refine existing measures, and improve their usefulness for measuring productivity growth. Other initiatives relevant to this effort are the following:

- Work with BLS to develop an integrated production account that will provide a more consistent framework for estimating the contributions of innovation

Table 4. A Summary of Selected Government Initiatives to Measure Innovation

Sponsor	Initiative	Description
U.S. Congress	COMPETES Act (P.L. 110–69) (August 2007)	Establishes a President's Council on Innovation and Competitiveness. In addition to policy monitoring and advice, the Council's duties include "developing a process for using metrics to assess the impact of existing and proposed policies and rules that affect innovation capabilities in the United States" as well as "developing metrics for measuring the progress of the federal government with respect to improving conditions for innovation, including through talent development, investment, and infrastructure development."
Office of Science and Technology Policy	Science of Science Policy Interagency Task Group	Established in October 2006, the task group is analyzing federal and international efforts in science and innovation policy, identifying tools needed for new indicators and charting a strategic road map to improve theoretical frameworks, data, models, and methodologies.
National Science Foundation	Science of Science and Innovation Policy (SciSIP)	Established in 2006, the initiative is expected to develop the foundations of an evidence-based platform from which policymakers and researchers may assess the nation's science and engineering enterprise, improve their understanding of its dynamics, and predict its outcomes. The research, data collection, and community development components of SciSIP's activities will · Develop theories of creative processes and their transformation into social and economic outcomes, · Improve and expand science metrics, datasets, and analytical tools, and · Develop a community of experts on SciSIP.
National Science Foundation	Workshop on Advancing Measures of Innovation: Knowledge Flows, Business Metrics, and Measurement Strategies (2006)	The workshop was in response to the challenge set forth by Dr. John H. Marburger III, the President's science and technology adviser, for better data, models, and tools for understanding the U.S. science and engineering enterprise. A number of strategies for data development were discussed · Survey-based methods, · Data linking and data integration, · Nonsurvey-based methods (such as mining of administrative data), and · Using case studies and qualitative data. These diverse strategies are not mutually exclusive.
National Science Foundation	Business R&D Innovation Survey	This new survey covers a variety of data on the R&D activities of companies operating in the United States. The five main topic areas are the following: · Financial measures of R&D activity, · Company R&D activity funded by others, · R&D employment, · R&D management and strategy, and · Intellectual property, technology transfer, and innovation.
Organisation for Economic Co-operation and Development (OECD)	OECD Innovation Strategy	The goal is to help policymakers improve framework conditions for innovation and trigger a virtuous circle driving growth. This project is built around evidence-based analysis and benchmarking. It will include a framework for dialogue and review, new indicators on the innovation-economic performance link, initiatives for innovation-friendly business environments, and the development of best practices and policy recommendations.
Department of Commerce	Advisory Committee on Measuring Innovation in the 21st Century Economy (2008)	This committee of business and academic leaders was charged to develop new and improved measures of innovation in three areas: · How innovation occurs in different sectors of the economy, · How it is diffused across the economy, and · How it affects economic growth.

Source: Stone, et al. 2008.

to economic growth and productivity. Harper, Moulton, Rosenthal, and Wasshausen (forthcoming) provide annual estimates at the aggregate level. Next steps, which will require incremental funding, include expansion to industry-by-industry estimates and quarterly estimates.

- Work with the NSF and the Census Bureau to develop detailed estimates of innovation-related intermediate inputs. These inputs, ranging from IT equipment to scientists and engineers, are critical to understanding the sources of innovations own contributions to growth.
- Work with the NSF and the Census Bureau to publish innovation statistics on firm- and establishment-level data in order to provide more comprehensive estimates of employment in innovation occupations.
- Begin exploring methods and data sources to construct estimates for human capital, an important conduit for the diffusion of innovations.

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