

R&D and Other Intangible Assets
in an Input-Output Framework:
Experimental Estimates with U.S. Data

By Carol A. Robbins, Mary L. Streitwieser,
and William A. Jolliff

18th International Input-Output Conference
June 20-25, 2010
Sydney, Australia

Carol A. Robbins
U.S. Bureau of Economic Analysis
1441 L Street, NW
Washington, DC 20230, USA
Carol.Robbins@bea.gov

Mary L. Streitwieser
U.S. Bureau of Economic Analysis
1441 L Street, NW
Washington, DC 20230, USA
Mary.Streitwieser@bea.gov

William A. Jolliff
U.S. Bureau of Economic Analysis
1441 L Street, NW
Washington, DC 20230, USA
William.Jolliff@bea.gov

The views expressed in this paper are solely those of the authors and not necessarily those of the U.S. Bureau of Economic Analysis or the U.S. Department of Commerce.

ABSTRACT

The U.S., along with many other countries, plans to adjust official economic statistics in coming years to recognize R&D and several other intangibles as capital assets. We present here experimental estimates of the impact of capitalized intangibles on industry output and industry value added. We do this using the concepts of the 2008 System of National Accounts (SNA) for classifying intangible assets, along with the framework of the U.S. input-output (I-O) accounts. The intangibles we treat as assets are R&D expenditures, entertainment, literary, and artistic originals, and architectural and engineering design originals. R&D expenditures and entertainment, literary, and artistic originals are explicitly identified as produced intangible assets. We argue that some architectural and engineering design originals, while not explicitly identified as such in the SNA, fit within the SNA definition of produced assets.

Based on our experimental measures, new private intangible investment in R&D, entertainment, artistic, and literary originals, and engineering and architectural originals was 218 billion dollars in 2002. If these intangibles were treated as investment, the result would more than double the existing estimate of intangible capital compared with published measures of new private fixed investment in intangible assets in the U.S. economic accounts. While all sectors invested in these newly measured intangible assets, the distribution across sectors was heavily skewed: R&D accounted for three quarters of this new investment, with manufacturing R&D accounting for one half of this new private intangible investment. Our experimental estimates indicate investment in entertainment, literary, and artistic originals accounted for 16 percent of new private intangible investment, with 85 percent of this occurring in the information sector. Investment in architectural and engineering designs was spread across all sectors, however, two sectors accounted for 85 percent of this investment – professional and managerial services (63 percent) and construction (22 percent).

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Introduction

Economic activity increasingly involves market-based creation and transfer of ideas. The gap between this activity and its reflection in standard economic measurement risks imprecise statistics, both in aggregate and on an industry basis. A multitude of papers on knowledge-intensive economic activity, innovation measurement, as well as human and intangible capital address various aspects of this measurement issue. One thing that everyone agrees on is that measuring intangibles is not easy, and no one has all the data needed to do a comprehensive job. It is also generally agreed that not measuring intangibles as capital is a worse choice than measuring them less than perfectly. Although data limitations and measurement challenges inevitably distance official economic statistics from ideal measures of intangible capital investment, if the bias caused by this measurement gap is growing over time, as has been argued, this issue takes on some urgency. A question emerges, what can be incorporated into the national accounts with an acceptable degree of accuracy and conceptual clarity?

In this paper we prepare experimental estimates of intangible investment by industry in order to test the suitability of existing source data and methodology. Our paper uses survey data from federal statistical agencies to propose methods that make a major step forward to bridging the gap in official statistics for the U.S. on the impact of capitalized intangibles on industry output and industry contributions to GDP. We do this using the concepts of the 2008 System of National Accounts (SNA) for classifying intangible investment, along with the framework of

Ana Aizcorbe, Mahnaz Fahim-Nader, Brian Moyer, Carol Moylan, Erich Strassner, and David Wasshausen provided valuable comments. The authors benefited from research by and discussion with Rachel Soloveichik on entertainment, literary, and artistic originals as intangible capital assets.

the U.S. input-output (I-O) accounts. The intangibles we treat as investment are R&D expenditures, entertainment, literary, and artistic originals, and architectural and engineering design originals. Computer software and mineral exploration are produced intangibles that are already treated as investment in BEA's accounts. In 2013, BEA plans to extend the types of produced intangibles that are treated as capital formation in the national accounts to include research and development expenditures and some types of entertainment, literary, and artistic originals protected by copyright (Aizcorbe et al., 2009). In contrast, our treatment of architectural and engineering design originals as intangible investment is exploratory.²

Based on our experimental measures, new private intangible investment in R&D, engineering and architectural originals, and entertainment, artistic, and literary originals was 218 billion dollars in 2002. If these intangibles were treated as investment, the result would more than double the existing estimate of intangible capital in BEA's measures of new private fixed investment. While all sectors invested in these newly measured intangible assets, the distribution across sectors was heavily skewed: R&D accounted for three quarters of this new investment, with manufacturing R&D accounting for one half of this new private intangible investment.

Our experimental estimates indicate investment in entertainment, literary, and artistic originals accounted for 16 percent of new private intangible investment, with 85 percent of this occurring in the information sector.³ Investment in architectural and engineering designs was spread across all sectors, however, two sectors accounted for 85 percent of this investment – professional and managerial services (63 percent) and construction (22 percent).

Expanding the scope of measured capital investment to include these intangible assets has an impact on industry value added. The information sector showed the largest percent increase

² Some engineering and architectural services expenditures are currently included as part of the value of installed equipment and structures. Our treatment here is a recognition of the design as a separate intangible asset.

³ The methodological work for these entertainment, literary, and artistic originals is ongoing.

in the level of value added, 8.8 percent; the level of value added for the manufacturing sector increased by 8.7 percent.

This paper is organized as follows. In section 1 we describe the key measurement issues for intangible capital in the national accounts. In section 2 we summarize the recent literature on the capitalization of intangibles and measurement and data issues that emerge from this literature. Section 3 briefly describes how the I-O tables will change with capitalizing intangible assets, including changing the measure of industry output and value added. In section 4 we describe the industries that are the main producers of intangible capital, the data sources and methodology used, and our prototype estimates for industry sectors. Section 5 concludes, describing next steps in the work to integrate these measures into the industry accounts. Details on how the I-O accounts change when intangible assets are capitalized are presented in Appendix A and details on our estimation methodology are provided in Appendix B.

1. Key Measurement Issues for Intangible Assets

1.1. What Counts as Intangible Capital?

While ‘capital’ refers to resources that contribute to future economic output, the defining characteristics of intangible capital can be most tersely described by what it is not—not physical (plant and equipment), and not financial (stocks, bonds, and other similar instruments). Business valuation of intangibles recognizes identifiable intangible assets such as patents, copyrights, trademarks, trade secrets, research and development, and computer software code, and unidentifiable intangible assets such as goodwill and human capital (Cohen, 2005). Some views of intangible capital emphasize the intangible capital embodied in humans, including not only

formal education and work experience, but also hard to quantify personal assets, such as persistence, empathy, and competitiveness (Tomer, 2008).

For our study, we are interested in a measure that conforms to national accounting standards for measures of productive capital and reproducible wealth. That is to say, our experimental estimates are designed to be consistent with the concepts of the System of National Accounts.⁴ Where internally consistent survey data are currently available, we propose experimental estimates. Where these data are not yet available, we call for expanded data collection within a consistent measurement framework.

We define produced intangible capital as the long-lived and useful result of productive activity that can exist separately from any material object. These products include computer software, mineral exploration, entertainment, literary, and artistic creations, scientific and engineering innovations and designs, as well as the ideas for new products. Specific examples include a musical score, a collection of poetry, the plans for new machinery or structures, computer programs, and formulas for new chemical or pharmaceutical products. For this paper, we do not make estimates for human capital or economic competencies, such as marketing and business organization.

1.2. How Can Intangible Output be Measured?

When available, expenditures for intangible inputs at market prices are preferred. However, because intangibles are often used within firms and not sold directly, other measurement methods must be considered. Options are production costs, net present value estimates of income flows, or expenditures for comparable products that are sold in the market. Each alternative to market prices has substantial limitations.

⁴ The relatively broader view of intangible investment proposed by Corrado, Hulten, and Sichel (2006, 2007) has played an important role in helping us to refine our thinking about not only what to treat as investment, but also how to develop additional source data. We discuss this work in more detail in section 2.

Although production costs are widely used to value nonmarket commodities, when intangible assets are protected as intellectual property, the relevant market may have more in common with monopoly than with perfect competition. This leads to a wedge between market prices and production costs. Thus, the best available alternative should be judged based on the purpose of the estimate. For example, to understand the upper boundary of the possible value of intangibles, it may make good sense to use a net present value estimate that risks attributing other benefits to the value of intangibles. This method is less attractive when the task involves separately identifying the value of several intangibles. For the purposes of regularly updated national account statistics, data that are internally consistent with other components of the national accounts and updated at similar frequencies may integrate more readily.

2. Literature Review

Nakamura (2001) takes a broad view of the possible impact on the U.S. national accounts of capitalizing intangibles, using three different methods to estimate unmeasured investment of approximately 1 trillion dollars annually in intangibles. He defines these investments as “private expenditures on assets that are intangible and necessary to the creation and sale of new or improved products and processes.” These intangible investments include R&D, financial innovations, advertising, marketing, publishing, motion pictures, and sound recording expenditures. He estimates for private business 1) how much business users pay for their intangible investments, 2) how much workers engaged in creative occupations are paid, and 3) how much corporations earn from these investments. These corporate earnings are estimated as the difference between revenues and the cost of goods sold. Including software already capitalized in the national accounts, he estimates at least 1.1 trillion dollars of investment in 2000, implying a substantial under-measurement of U.S. GDP.

Corrado, Hulten, and Sichel (CHS, 2006) extend Nakamura's framework to include business organizational capital, and show the implications for growth accounting. They allocate growth in economic output to quantities of capital services and labor services, and to the total factor productivity residual.

They argue that the determination of what should be considered capital versus consumption can best be understood from the perspective of consumer utility maximization. Capital expenditures are those that subtract from current period consumption to increase consumption in the future. Thus, from the perspective of the consumer, there is no basis for treating intangible capital differently from tangible capital. They argue that the national economic accounts should be extended to include all the forms of intangible capital that fit this definition.

Their set of intangible capital assets has three broad categories: computerized information, innovative property, and economic competencies. Computerized information includes computer software and computerized databases. Innovative property includes not only the R&D activity of scientists and engineers, but also new product design and development costs in other creative activities, and mineral exploration costs. Economic competencies include expenditures for advertising and marketing, the development of firm-specific human capital, and costs for organizational formation, change, and development.

With this expanded view of capital, the sources of growth in economic output shift somewhat. CHS find that, based on their estimates, capitalizing all these intangibles raises capital's share of national income from 31.8 percent to 40 percent, and intangible capital accounts for 37.5 percent of capital income. Labor's share drops from 68.2 percent to 60 percent. Capitalizing intangibles increases the rate of growth in output per hour 20 percent in the

period from 1973-1995 and 11 percent in the period from 1995-2003. Multi factor productivity declines in the period from 1995-2003 from 1.42 percentage points to 1.08 percentage points.

The CHS framework has been applied to many countries since 2006. These include Fukao and Hamagata (2007) for Japan; Marrano, Haskel, and Wallis (2007) for the United Kingdom; Van Rooijen-Horsten et al. (2008) for the Netherlands; Belhoucine for Canada (2009); Barnes, and McClure, for Australia (2009); Jalava (2007) for Finland; and Delbecque and Laurence Nayman (2010), for France.

2.1. Intangibles as Capital in Published Economic Statistics

Many of the nation and region specific implementations of the CHS framework for new intangibles have been done by the staff of national statistical agencies. Part of their contribution includes detailed knowledge of statistical source data and the measurement concepts of both their own-accounts and the internationally recognized standard for national economic statistics, the SNA. The SNA is periodically revised to improve and refine its recommendations for economic measurement, as well as to reflect changing economic reality of the global national accounting community. The 1993 SNA first recommended the capitalization of mineral exploration, computer software and large databases, and entertainment, artistic, and literary originals (CEC, 1994).

While the most recent version of the SNA, completed in 2008, includes more produced intangible assets compared with the earlier version, the defining qualities of a produced fixed asset within SNA remain constant. First, there are returns from holding and using the asset, second, the benefits are expected to last more than a year, and third, there is an economic owner for the asset.⁵ The long term benefits distinguish fixed assets from the consumption of

⁵ SNA 2008, paragraph 10.8.

intermediate inputs, which are completely transformed or used up in the production process.⁶

The SNA also requires that an asset have an economic owner, who claims the benefits of the use of the asset, and accepts the associated risks.⁷

The 2008 SNA recommends that when intellectual property products can provide some form of monopoly benefits, they should be treated as an asset. These intellectual property products are defined as the “result of research, development, investigation or innovation leading to knowledge that the developers can market or use to their own benefit in production because use of the knowledge is restricted by means of legal or other protection.” R&D expenditures are explicitly treated as assets, even though these expenditures may not always be covered by intellectual property protection. In the 2008 SNA, human capital is explicitly excluded because of the difficulty identifying ownership and marketing expenditures are excluded because of the difficulty in measuring their value.⁸

The following intangibles are gross fixed capital formation (GFCF) within the 2008 SNA⁹:

- Computer software and databases,
- Mineral exploration,
- Entertainment, literary, and artistic originals,
- R&D expenditures,
- Other intellectual property products (unspecified).

Table I shows the current treatment of these intangibles as investment within the national accounts of several countries. In the U.S. and in many other countries, computer software is currently treated as capital. Several countries, though not the U.S., currently capitalize costs for creating copyrighted entertainment, artistic, and literary originals.

⁶ SNA 2008, paragraph 6.213.

⁷ SNA 2008, paragraph 3.26.

⁸ For ownership, see SNA 2008, paragraphs 3.26, 3.46, and 3.48; for marketing, SNA 2008, paragraph A4.53.

⁹ *GFCF* is the term used by the SNA for acquisitions less disposals of fixed assets; BEA uses the term *gross fixed investment* for the same concept.

[Table I placed here.]

The U.S. and many other nations currently capitalize mineral exploration expenses, and are now planning to include R&D expenditures as investment in official statistics. Australia incorporated R&D as investment in its accounts in December 2009 (Sutton, 2009). To our knowledge, economic competencies are not currently treated as investment in any official set of national accounts.

2.2. International Experience with Intangibles Measurement

In the section that follows, we summarize the methods used to measure currently capitalized intangibles, as well as some of the insights drawn from several implementations of the CHS framework for extending the measurement of intangibles as assets. The impact of these new intangibles on GDP ranges from 5.9 percent for Australia to 13.1 percent for the U.S. The range of impacts depends on both the industrial characteristics of national economic activity and the assumptions that are adopted when appropriate source data are insufficient. There are two main limitations to the available source data for measuring intangible assets. The first problem is measuring the expenditures for the creation of intangibles, and the second is identifying the share of intangible output that is investment rather than consumption. For the country-specific studies referenced below, Table II summarizes the magnitude of these measures relative to unadjusted GDP.

(Table II placed here.)

2.3. Computerized Information

This category is treated as investment in the 1993 SNA. Because most OECD countries adopted the treatment of computer software as an asset by the year 2000, these measures can

come directly from the national accounts statistics.¹⁰ In the U.S., investment in purchased software is estimated using the commodity flow method, where the addition to capital is the residual remaining after accounting for sales to other sectors. Own-account software is estimated based on production costs, primarily consisting of labor costs. Belhoucine (2009) and Delbecque and Nayman (2010) note that it is difficult to separate out the spending for own-account databases from computer software. For both of these CHS-style studies, an estimated portion of the purchases from the database activities industry is treated as purchased assets.

2.4. Innovative Property

This category includes intangible assets that reflect both technological and creative innovations.

2.5. Entertainment, Artistic, and Literary Originals (Copyright Costs)

For many of the countries that created experimental statistics, entertainment, artistic and literary originals are already treated as capital in their accounts, and so measures can come directly from their published statistics. For Australia, the value of movie and independent television originals is estimated from the present value discounted flow of receipts from movies, based on data from the Australian Film Finance Commission. Data on own-account production for television comes from Australian Bureau of Statistics' (ABS) industry statistics for Film and Video Production and Distribution and from the financial results of the Australian Broadcasting Authority (ABS, 2000). For recorded music, the production cost approach is used, combining data on Australian sales from the Australian Recording Industry Association with production costs obtained from a sample of major record companies. The value of published music is

¹⁰ Within these statistics, the coverage of databases has been less uniform (OECD, 2010). The U.S. does not treat databases as a separate commodity within gross fixed investment. However, to the extent that own-account (internally used) software creates computerized databases, this portion of databases is considered to be included within gross fixed investment in software (Aizcorbe, 2009).

estimated by combining ABS data on the advance a publisher pays a songwriter or composer with the publisher's share of the expected royalties. For literary originals, the ABS estimates the lump-sum payment a publisher pays an author as the value of the original, using ABS data from the publishing industry.

Where national accounts data are not directly available, industry output measures are used for CHS-style estimates. For Japan, for example, Fukao and Hamagata (2007) make an estimate of the value of artistic, literary, and entertainment originals as copyright costs, using the nominal output of the publishing and newspaper industry and the video picture, sound information, character information, and distribution industry.

For the U.S., Soloveichik (2010) estimates nominal and real production, price indexes and depreciation schedules, and real capital stock for these intangibles from 1929 to 2006. She estimates that \$65.1 billion, or 0.6% of GDP, in entertainment, literary, and artistic originals were produced in 2002. These intangible assets include \$9.8 billion in films, \$35.6 billion in long-lived television programs, \$7.6 billion in musical works, \$7.1 billion in literary works, and another \$5.0 billion in miscellaneous artistic originals. These miscellaneous artistic originals include maps, greeting cards, commercial photography, and scripts and musical scores for performance art, such as dance, opera, and theater.

In Soloveichik's experimental measures, nominal values for theatrical movies and television programs are measured by production costs, including overhead. Books, music and other artistic originals are measured by industry revenue less advertising, manufacturing, and customer support expenses. Industry revenues from the 2002 Economic Census are the primary data. Production expenditures, as a percent of revenue, are based on the Census Survey of Annual Services and industry literature. Specifically, production costs for films are 39 percent of

industry revenue for theatrical movies; 40 percent of industry revenue for capitalized television programs; 54 percent of musical industry revenue; 28 percent of book publishers' revenue; and 15 percent of industry revenue for miscellaneous artistic originals.

2.6. Mineral Exploration

The activity covered by this category has been included as capital in the SNA since 1993 and includes acquisition of the rights to explore, exploratory drilling and sampling, various topographic and geo-scientific studies, and evaluation of both technical feasibility and commercial viability. For major producers, such as Australia and Canada, the needed detailed survey data are already in place for the construction of economic accounts (ABS, 2000; Baldwin, et al., 2008).

2.7. Research and Development, including Financial Innovation

The widely used definition of R&D from the OECD's Frascati Manual is that it is activity whose purpose is to increase the stock of knowledge, including knowledge of man, culture, and society that is used to devise new applications. Conceptually, this should cover all industries and incorporate social science and humanities. Country-specific practices vary considerably with respect to on the coverage of the surveys used to collect these data.

In the experimental CHS estimates for the Netherlands, Van Rooijen-Horsten et al. (2008) assume that the Dutch R&D survey covers R&D activity in the financial services industry as well as R&D in the areas of social science and humanities. By contrast, Marrano, Haskell, and Wallace (2007), and Fukao and Hamagata (2007), assume it is not fully covered, and follow the CHS recommendation of 20 percent of all intermediate purchases from the financial services industry, less any double-count with other intangibles. Barnes and McClure (2008) use this

measure as an upper bound, and use as an alternative the R&D spending by financial firms from the Australian R&D survey.

2.8. New Architectural and Engineering Designs

Many national accounts, including those of the U.S., already include some of these expenditures as part of residential investment or as part of the installed value of equipment and structures, but this treatment recognizes the role of the designs in the value of the tangible asset that is used repeatedly, rather than the separate role of the design in multiple uses. As a separate intangible asset, the capitalized component of designs reflects this separate quality. Because their use can be controlled through intellectual property protection, they share many of the qualities of capitalized R&D.

CHS (2005) treats 50 percent of the revenues of the architectural and engineering services industries as capital. Marrano, Haskel, and Wallis (2007) follow this recommendation, and add twice the revenues of the specialty design sector as a measure of own-account design. Van Rooijen-Horsten et al. (2008) assume that two thirds of the architectural and engineering designs used for capital goods are used repeatedly, and treat this share as an asset.

2.9. Economic Competencies

Economic competencies are created through expenditures for brand equity, human capital, and business organization. Currently, none of the countries that created experimental estimates treat these activities as investment in their national accounts, and data for precise measurements in this area are scarce. As a result, there is wide variation in size of this category of intangibles across countries. Estimates for the share of GDP devoted to economic competences ranges from 2.5 percent for Japan from Fukao and Hamagata (2007) to 6.9 percent in CHS (2005) for the U.S.

For the brand equity component, data are not available to indicate with any accuracy the share of advertising and marketing expenditures that have a long-lasting impact on production. Van Rooijen-Horsten et.al (2008) evaluates eight categories of advertising and marketing expenditures, and assign ratios of zero, one or 50 percent to seven of the eight categories. For advertising in newspapers and journals, they use the share of advertisements that are for employment to identify the non-capital forming component. The estimates by Marrano, Haskel, and Wallis (2007), Fukao and Hamagata (2007), Barnes and McClure (2009), and Baldwin, et al. (2008) follow the CHS recommendation that 60 percent of advertising and market revenue be considered investment.

2.10. Firm Specific Human Capital

Firm-specific human capital consists of the cost of providing training and wages for the workers while they are trained. Van Rooijen-Horsten et al. (2008) use data from a vocational training survey conducted periodically by Statistics Netherlands to estimate firm expenditures, and Barnes and McClure (2009) use a combination of surveys on employment and training for Australia. Time series data are not available for the U.K., however, so Marrano, Haskel, and Wallis (2007) use survey data from 2005, and estimate earlier and later growth with proxy measures.

2.11. Organizational Capital

For investment in organizational capital, CHS (2005) use receipts for management consultants to estimate purchased organizational capital and capitalize 80 percent of this as purchased investment. For the own-account component, they take one fifth of managers' earnings. Van Rooijen-Horsten et al. (2008) their measure purchased organizational structure based on the industries in the Netherlands that provide organizational and economic advice:

organizational consultancy, market research agencies, public relations agencies, and other economic research and consultancy. For own-account organizational structure, they follow the CHS estimate of 20 percent of management time; lacking data for Dutch occupations, they use a German survey to develop proxy measures. For the UK, Marrano, Haskel, and Wallis (2007) also use receipts for management consultants for purchases; capitalize 80 percent of this as purchased investment; and take one fifth of managers' earnings to estimate own-account organizational capital. Barnes and McClure (2009) observe that organizational capital, along with firm specific human capital, is particularly difficult to estimate. For Australia, they use purchases from a broader aggregate, the business management services industry. Fukao and Hamagata (2007) are not able to estimate purchased organizational structure from Japanese industry data, but do include a measure of own-account organizational structure at 20 percent of executives salaries and bonuses.

3. Conceptual Issues in Capitalizing Intangible Assets: How the Accounts Change

Changing the accounting treatment of intangibles from consumption to investment has different impacts on the I-O accounts, depending on whether the final user of the intangible is primarily a market producer (business) or a nonmarket producer (government or nonprofit entity serving households).

Assets that are produced by businesses for internal use are a form of nonmarket production, though the producer is part of the market sector. For market producers, recognizing own-account intangibles as investment adds to gross output. Recognizing purchased intangibles as investment decreases intermediate consumption. The result of these two changes is that value added, or GDP, increases by the sum of business purchases of intangibles plus own-account investment in intangibles.

For nonmarket producers, for example governments, gross output is measured by the sum of costs: labor and capital services, and intermediate inputs. Changing the accounting treatment of intangibles for nonmarket producers has two impacts on gross output that have opposite signs. Gross output decreases by nonmarket purchases of intangibles, since these purchases are no longer intermediate inputs. Gross output increases by the amount of capital services flowing from the stock of intangible assets. In aggregate, value added for nonmarket producers is only affected by the added capital services flow, estimated in the national accounts by consumption of fixed capital.

Thus, the overall impact of capitalizing intangibles on the level of GDP is the sum of business investment in intangibles plus the consumption of fixed capital flow of intangibles to the nonmarket sector. In our paper, only R&D and a small portion of architectural and engineering originals become investment for the nonmarket sector. For additional explanation of these impacts across industries and commodities, we provide three tables and a detailed explanation of the changes in Appendix A.

4. Data, Methodology, and Estimates

In this paper we develop experimental estimates for R&D, entertainment, artistic, and literary originals, and for architectural and engineering originals. In our implementation, the capitalization of intangible assets does not change either the overall industry and commodity classification nor the special definitions and conventions of the I-O accounts. Wherever possible, industries and commodities in the I-O accounts are classified consistently with the 2002 North American Industrial Classification System, or NAICS. No new industries are created to deal with intangible assets, only new commodities, specifically “own-account” and “for sale”

commodities. The estimates presented here are presented primarily at the NAICS industry sector level. They are at nominal levels for 2002, the most recent year of the benchmark I-O accounts.

The R&D and entertainment, literary, and artistic intangible activities currently identified in the I-O accounts are service commodities produced by businesses, nonprofit institutions, government. Our treatment capitalizing intangible assets does not change the commodity output of industries; however it does shift final use of some of these commodities from intermediate consumption to capital investment.

On the other hand, we do need to create new commodities to account for the own-account intangible activities. Own-account intangible activities are those performed by businesses, governments, or nonprofit institutions, rather than by purchasing from a producing business. These own-account activities shift from being treated as intermediate inputs to being treated as capital investment. Much of non-government R&D is own-account. Similarly, most of entertainment, literary, and artistic original investment is own-account production. Table III presents our list of intangible commodities and their producing industries.

(Table III placed here.)

Own-account capital assets, by definition, are used by the producing industry. New for sale capital assets are distributed to the using industry based on the existing use in the I-O table. For example, all industries that purchased photographic services as intermediate inputs in the 2002 I-O table, are now shown to purchase photographic design capital assets. The commodity values in the table showing the industry uses of new intangible capital, table A.III in Appendix A, are the sum of both own-account and for purchase new capital assets.

4.1. Research and Development

The scope of R&D that we aim to estimate in the accounts is broad, and based on the OECD's Frascati Manual for R&D surveys.¹¹ In our treatment, a new commodity is created: R&D services for internal use or own-account. The make table (table VII) shows the details of R&D related services produced by industries, either for sale or for own-account. For example, the chemical manufacturing industry (NAICS 325) produces chemicals and drugs as its primary products, and produces a secondary product, chemical-related R&D services, for its own use. R&D related services produced by other industries are treated similarly.

Our estimate of R&D is based on BEA's R&D satellite account. It is largely based on the cost of production, and is adjusted for the overlap between own-account R&D activity and own-account software. After adjusting for a 24.0 billion dollar overlap, we estimate business investment in R&D in 2002 at 159.5 billion dollars, 117.3 billion dollars of own-account R&D, and 42.2 billion dollars in purchased R&D. We estimate an additional 7.2 billion dollars in private nonprofit investment in R&D.

The primary data source for these statistics is the National Science Foundation (NSF) Survey of Industrial R&D (SIRD). The SIRD provides estimates of R&D expenditures for all domestically performed R&D in companies with five or more employees. The scope of activity covered in the R&D data currently available is science and engineering R&D, which excludes R&D activity in the social sciences and humanities.

These costs from the SIRD are summed to estimate own-account R&D investment for the R&D satellite account. Industry funds for R&D performed by other domestic companies are reconciled with NSF data on R&D performance to estimate industry purchases of science and

¹¹ The manual defines R&D as: "...creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture, and society, and the use of this stock of knowledge to devise new applications (paragraph 63)."

engineering R&D. Economic Census data on receipts for the social science component of the R&D services industry are used for business purchases of social science R&D, which we estimate at 2.5 billion dollars. At this point, no estimate is made for own-account social science R&D.

Additional details on the methodology used to develop the R&D estimates are provided in a series of background papers available on BEA's web site: www.bea.gov/national/rd.htm. For specifics on R&D by industry, see Robbins, Candela, Fahim-Nader, and Medeiros (2007).

4.2. Entertainment, Literary, and Artistic Originals

To define our commodities in this category, we rely on the OECD's recent handbook on the measurement of intellectual property products (2010). Entertainment, literary, and artistic originals to be capitalized include films, television programs, literary works, musical works, photographic images, and the scripts, scores, and choreography of performance art, such as opera, dance, and plays. Our primary data sources for entertainment, literary, and artistic intangible assets are the Census Bureau's Economic Census and Annual Service Survey. We supplement these census data with other industry specific information, including cost share ratios developed by Soloveichik (2010). Our estimates are based on production costs or net present value, depending on the best available data, as described below. Additional detail on the data and methodology are presented in the Appendix B.

4.2.1. Films

Motion picture films include the edited, final version of short and long films produced for commercial theaters, and other distribution, such as tapes, DVDs, and direct-to-video. We also include a portion of revenues from non-film merchandise, which includes such commodities as toys, clothing and other items associated with specific movies. For our measures, all types of

original films are considered within scope, from silent movies to those with special three-dimensional effects. Music videos are not included, as these are included with music. Movies originally intended for television are included with television programs. Motion pictures films are produced in the Motion picture and video industry (NAICS 5121), typically as an own-account asset commodity.

Virtually all films are produced as own-account assets, thus we do not observe a market price for these types of intangibles. For this reason, the OECD (2009) recommends estimating the value of original films based on production cost. Soloveichik (2010) uses reported production budgets for films to estimate production costs for an original film, which exclude advertising, selling, and other overhead expenses. We adopt her estimates that 46 percent of operating expenses represent the cost of producing an original movie. Based on reported revenue, operating expenses, and Soloveichik's estimate of production costs, we estimate the value of original films produced in 2002 was 9.3 billion dollars.

4.2.2. Television and Radio Programs

In our estimates, we follow the SNA and consider only long lived "stock" television and radio programs as capital assets. Stock programs include documentaries, drama, music, arts, history, and educational programs that likely will be shown repeatedly and/or replicated in other countries. "Flow" programs, on the other hand, are not capitalized because they are not likely to be broadcast more than once. Examples of flow programs include game shows, news, sports events, and daytime "soap operas." Advertising on television also is excluded. Soloveichik

(2010) estimates, based on Nielsen ratings data, that in the U.S. about one third of all broadcasting is of stock programs.¹²

For the U.S. we did not identify any radio programs that meet the criteria to be considered intangible capital assets. We focus exclusively on stock television programs, that are produced as own-account in three industries:¹³ 1) Motion picture and video industries (NAICS 5121), which produces programs and licenses them to broadcasting stations and to cable and satellite distribution companies, who in turn, provide television programs to viewers; 2) Radio and television broadcasting (NAICS 5151), which are the network affiliates, local broadcast stations, and public stations that produce television programming for direct broadcast to viewers or by licensing agreement to cable and satellite distributors; and 3) the Cable and other subscription programming (NAICS 5152). This industry also produces television programs which are licensed to broadcasting stations and to cable and satellite distribution companies for broadcast to viewers.

Using the same production cost approach as for film originals, we estimate 9.4 billion dollars in own-account long-lived television programs were produced in 2002.

4.2.3. Literary Works

Our proposed measures for literary works aim to include all long-lived published written works with separate copyrights, regardless of subject, style or media. Thus, we include printed, audio, and multimedia versions of books, pamphlets, maps, and greeting cards. According to the SNA, film scripts and film music scores that are copyrighted separately from motion pictures are included in this category of intangibles; however, we are not able to identify any scripts or music

¹² Nielsen data on television programming by gerund includes a category for “dramas,” which includes both daytime “soap operas” and evening drama shows. Therefore Soloveichik’s estimates and our own include “soap operas” even though they are not considered stock programming by the SNA.

¹³ There is a fourth television industry defined in NAICS: Cable and other program distribution (NAICS 5175), that distributes programming to viewers, but does not produce original programming.

scores meeting the criteria. Newspapers, periodicals, and magazines are excluded, except for books licensed for serial publication in magazines. We elected to include maps and greeting cards in with literary works, rather than with artistic originals as suggested by the SNA, as their production and marketed are similarly to books and occur in the same industry.

Literary works are generally first created by a single, or a small group of authors. Therefore, one might expect literary works to be an own-account commodity produced by Independent artists, writers, and performers (NAICS 7115). However, publishers provide editing, illustrations, and other value added services that make the final literary product. Because of this joint production, contractual arrangements for the collection and distribution of royalties for literary works effectively give joint ownership to the publisher. Our methodology for measuring original literary works recognizes this joint production and uses data from Newspaper, periodical, book, and directory publishers (NAICS 5111) and Other information services (NAICS 5191), which includes internet publishing.

We estimate that 8.6 dollars in original literary works were produced in 2002. These works include books, pamphlets, maps, greeting cards, and a very small portion of periodicals. We use the net present value of revenues to estimate the value of original literary works, as recommended by the OECD (2009) and developed by Soloveichik (2010).

4.2.4. Musical Works

All music under copyright and lasting longer than a year is within scope for this category, regardless of medium. Music videos are included; advertising scores and jingles are not. A piece of music may involve a composer/writer, musician(s), and performer(s). Thus there are four ways that a musician may earn royalties:

- Writing a musical score and/or lyrics;
- Recording music, either their own or another artists;

- Performing (live) music, either their own or another artists; and
- Licensing their music and/or lyrics to another performer.

Musical works are produced both as own-account and for purchase. Care must be taken to isolate the revenue stream only for the copyrighted original. As with literary works, royalties for musical works are earned, collected, and distributed for a variety of overlapping activities. Our methodology for measuring the value of musical works involves piecing together the value of original musical works using information from four industries: Newspaper, periodical, book, and directory publishers (NAICS 5111), the Motion picture and video industries (5121), the Sound recording industries (NAICS 5122) and Performing art companies (NAICS 7111).

We estimate 9.1 billion dollars in original musical works were produced in 2002.

Original music books and sheet music produced in 2002 are estimated at 0.2 billion dollars, using the same net present value of revenue methodology used for measuring literary works. Music videos add another 27.5 million dollars to the value of musical assets produced in 2002.¹⁴ We use cost of production to estimate the value of music videos as their production is similar to that of films and television programs and occurs in the same industry. The remaining 8.9 billion dollars in musical works was estimated by the net present value of the royalty and licensing incomes derived from recordings and live performances.

4.2.5. Other Artistic Originals

The last category of artistic originals to be capitalized includes a variety of artistic endeavors that are, on their own, relatively small, but still measurable. This category includes performance art and photographic originals.

¹⁴ Music videos were initially developed as a means to promote sales of recorded music, they have evolved to be their own form of “art,” playing on 24 hour television, the internet, and now are sold at iTunes stores for use on Apple’s iPod. Therefore, we elected to include music videos with music works to be treated as an intangible asset.

Performance art includes scripts, scores, and choreography for original plays, operas, dance, and some dinner theater. These artistic works, once created, can be performed over and over again. The category does not include live concerts because they are included with musical works. Own-account performance art is produced by Performance art companies (NAICS 7111). Based on admissions revenue, we estimate the net present value of these originals at 3.2 billion dollars in 2002.

Commercial photographic images are included in this category of intangible assets as they can be reproduced and used repeatedly, for promotional or illustration purposes, such as in newspapers, magazines, on posters, in books, or on television. We do not include portrait studio photography or wedding/events photos. Commercial photographic images can be made either for own-account or for purchase. Using revenue and licensing information on photography services from Other professional, scientific and technical services (NAICS 5419), we estimate 1.6 billion dollars in new long lived photographic originals were produced in 2002. Of this, the vast majority -- 1.5 billion dollars -- was produced for sale. Only 40.6 million dollars were produced as own-account capital, based on licensing data for use of stock photographs.

4.2.6. Other Intellectual Property Products: Architectural and engineering designs.¹⁵

Although these designs are not considered as artistic originals (OECD, 2009), for this paper, we extended treatment as intangible capital to architectural and engineering designs as intangible assets to capture the share of these designs that are used repeatedly, but separately from any tangible capital. For example, while the final design of a multi-story office building may include unique features, there is a portion of the design that is common to multi-story office

¹⁵ While the SNA 2008 does not specifically endorse capitalizing these intangibles, SNA 2008, paragraph 10.117 notes “Other intellectual property products include any such products that constitute fixed assets but are not captured in one of the specific items above.”

buildings. Similarly for engineering designs, there are certain aspects of engineering designs across similar projects that are used repeatedly.¹⁶

We find that these expenditures fit the definition of capital, and that while the total output can be estimated with reasonable precision, the share that is investment can only be approximated. By our measure, however, the magnitude is larger than some of the other categories. We estimate that Architectural, engineering, and related services (NAICS 5413) produced 5.5 billion dollars in original architectural designs that meet the criteria for capital, and 5.7 billion dollars in original engineering designs, for a total 11.2 billion dollars. After estimating the portion of this sold to government, private investment is 9.8 billion dollars.

4.3. Related Commodities

U.S. economic data from the Census Bureau includes receipts earned by several industries for licensing the rights to use intellectual property (IP). These receipts are sometimes also called royalties. These licensing receipts are a service commodity, where the right to use can be understood as the rental of an intangible asset that is protected as intellectual property. In most cases, the licensing or leasing of intellectual property allows the IP to be used in production without conveying ownership. Reported licensing receipts as income for an industry are indicators of two things: first, that the industry owns some intellectual property, and second, that it is using it in production by leasing it.

These licensing transactions can serve other functions as well. In the absence of other information about the value of entertainment, artistic, and literary originals, royalties can be used to develop at net present value of future receipts. In cases where a license to use also conveys

¹⁶ As noted earlier, some of these expenditures are currently part of fixed investment in equipment and structures, where the rationale is they represent a cost of integrating equipment and bringing it into production.

ownership and lasts for a period of more than a year, licenses may also be considered as separate products and treated as capital formation (OECD, 2009).

4.4. New Private Intangible Investment in 2002

Based on our experimental measures, treating these new innovative property intangibles as investment in the 2002 Benchmark I-O accounts would increase gross output by 161 billion dollars, and value added by 285 billion dollars, or 2.7 percent. This impact on value added comes from both the impact of business investment, and the added capital services flow for nonmarket sector output that is measured with CFC.

(table IV placed here.)

Based on our experimental measures, new private intangible investment in R&D, engineering and architectural originals, and entertainment, artistic, and literary originals was 218 billion dollars in 2002. While all sectors invested in these newly measured intangible assets, the distribution across sectors was uneven: R&D accounted for three quarters of this new investment, with manufacturing R&D accounting for one half of new private intangible investment (table V). Within manufacturing, R&D investment is concentrated in chemicals manufacturing, computer and electronics, and transportation equipment.

(table V placed here.)

Our experimental estimates indicate investment in entertainment, literary, and artistic originals accounted for 16 percent of new private intangible investment, with 85 percent of this occurring in the information sector. This concentration is because original films, television programming, and literary works are produced as own-account intangible assets in the information sector, as is the majority of musical works. Investment in architectural and engineering designs was spread across all sectors, however, two sectors accounted for 85 percent

of this investment – professional and managerial services (63 percent) and construction (22 percent).

Expanding the scope of measured capital investment to include these intangible assets has an impact on industry value added, as shown in table VI. The information sector showed the largest percent increase in value added, 8.8 percent. Value added for the manufacturing sector increased by 8.7 percent and value added for the professional and managerial services increased by 2.5 percent. For all other sectors the impact on value added was much smaller.

(table VI placed here.)

Tables VII, VIII, and IX show greater detail. Table VII, the make table, shows the impact on a sector-level make table for 2002, where industry gross output increase the most for the information sector (4.7 percent), due to the large share of own-account intangible output. Government output also increases, due to the impact of the capital services flow.

(tables VII, VIII, and IX placed here)

The use table (table VIII) shows the impact on value added for industry sectors. This value added impact (rows 28 and 29) is composed of private investment and CFC. Table IX shows the delivery of new intangible fixed assets to using industries.¹⁷ This table shows that deliveries to using industries increase the most for manufacturing and professional and managerial services, primarily from investment in R&D.

5. Summary and Conclusions

In this paper we show that several types of intangible assets that fit within the category of innovative property can be incorporated into an input-output structure for the U.S. economy

¹⁷ While this table is similar conceptually to a capital flow table, BEA did not publish a capital flow table for 2002. Expenditure flows for equipment, software, and structures for our table IX are based on new fixed investment flows from BEA's fixed asset data, along with information on the distribution of using industries from BEA's 1997 capital flow table.

using high quality and consistent survey data. These experimental estimates would more than double the value of intangible produced assets currently incorporated into the U.S. accounts in 2002.

We use a combination of methods to estimate output; for R&D activity we use primarily cost-based measures, while for entertainment, artistic, and literary originals we combine industry receipts with cost-based measures to estimate intangible investment. In addition to R&D activity and entertainment, artistic, and literary originals, we suggest that a share of architectural and engineering design originals both fit within the definition of capital for the 2008 SNA and can be estimated based on a share of revenues. Our measure for these design originals, 11.2 billion dollars, still has a large margin of uncertainty. Lacking information on the share that is used repeatedly, we choose a smaller ratio than is common in other comparable studies.

Our experimental estimates cover the range of SNA-recommended intangible capital. In comparison with the intangibles described by CHS as intangible capital, our estimates are conservative. Our reasoning for this more limited approach is two-fold: first, our attempt to keep our estimates within the scope of the SNA for core economic accounts, and second, our attempt to avoid making estimates of substantial magnitudes without strong source data.

In one area in particular that we would like to cover within these estimates, the absence of strong source data kept us from making an additional imputation-- financial services innovation. Expenditures for the development of new financial products appear to be within scope for the SNA 2008, and as Van Ark and Hulten (2007) have noted, these expenditures are unlikely to be included within the NSF survey on business R&D for the U.S. The range of international estimates for this component of innovative property suggests to us that an imputation here would be both very big, and have a wide potential margin of error. For this

reason, we conclude that it makes sense to work for improved source data in this area before recommending an estimate of financial services innovation in the core accounts.

In the area of economic competencies, there are components that can be measured with reasonable precision—marketing and consulting expenditures, for example. Business investments in human capital could be well measured with improved survey data. Although the SNA currently recommends against capitalization of marketing expenditures and human capital, as van Rooijen-Horsten et al. (2008) point out, there are parts of each that appear to fit within the language of the 2008 SNA. We look forward to more discussion on the topic, as well as the development of improved source data.

How to obtain the needed data? Experimental estimates must be created with existing data, with all the accompanying limitations. The practice of intangibles measurement has moved from this stage to the welcome phase of a multiplicity of new surveys specially designed for measuring intangibles and innovation. We suggest that adding questions to and modify existing surveys is a sensible approach as well because the data obtained through existing surveys will be more consistent with the rest of the source data used in the industry accounts for economic measurement. Finally, given the demonstrated value of cross-country comparisons in the measurement of R&D activity and innovation, we see substantial value in similar coordinated and integrated approach to the components of intangible capital that are currently measured weakly.

References

- Baldwin, John R., Wulong Gu, Amelie Lafrance, and Ryan Macdonald. *Investment in Intangible Assets in Canada: R&D, Innovation, Brand, and Mining, Oil, and Gas Exploration Expenditures*. Ottawa, Canada: Statistics Canada, Minister of Industry, 2008.
- Barnes, P. and McClure, A. *Investments in Intangible Assets and Australia's Productivity Growth*, Productivity Commission Staff Working Paper. Canberra, Australia, 2009.
- (CEC) Commission of the European Communities -Eurostat, International Monetary Fund, Organization for Economic Co-operation and Development, United Nations, World Bank (1994). *System of National Accounts 1993*, Brussels/Luxembourg, New York, Paris, Washington, DC
- Cohen, Jeffrey. *Intangible Assets: Valuation and Economic Benefit*, Hoboken, New Jersey, John Wiley and Sons, Inc., 2005
- Corrado, Carol, and Charles Hulten and Daniel Sichel. "Measuring Capital and Technology: An Expanded Framework." In *Measuring Capital in the New Economy*, edited by Corrado, Carol, John Haltiwanger and Daniel Sichel. Chicago, University of Chicago Press, 2005.
- Corrado, Carol, and Charles Hulten and Daniel Sichel. "Intangible Capital and Economic Growth," Finance and Economics Discussion Series, Divisions of Research & Statistics and Monetary Affairs, Federal Reserve Board, Washington, D.C., 2006.
- Delbecque, Vincent and Laurence Nayman. "Measuring Intangible capital: an application to the French data, 2010.
- Fukao, Kyoji, and Sumio Hamagata. *Intangible Investment in Japan: Measurement and Contribution to Economic Growth*. Research Institute of Economy, Trade and Industry. Discussion Paper Series 07-E-034, 2007.
- Fraumeni, Barbara. "The Measurement of Depreciation in the U.S. National Income and Product Accounts," *Survey of Current Business* 77 (July 1997): 7-23.
- Jalava, Jukka, Pirkko Aulin-Ahmavaara, and Aku Alanen. "Intangible Capital in the Finnish Business Sector, 1975–2005." Discussion paper no. 1103. Helsinki, Finland: The Research Institute of the Finnish Economy, 2007.
- Jona-Lasinio, C., M. Iommi, and S. Manzocchi., "Intangible capital and Productivity Growth in European Countries," Working Paper, Luiss Lab of European Economics, Rome, January 2010.
- Marrano, Mauro Giorgio, Jonathan Haskel, and Gavin Wallis. "What Happened to the Knowledge Economy? ICT, Intangible Investment and Britain's Productivity Record Revisited," Working Paper No. 603, Queen Mary College, University of London, 2007.

Meade, Douglas S., Stanislaw J. Rzeznik, and Darlene C. Robinson-Smith. "Business Investment by Industry in the U.S. Economy for 1997." *Survey of Current Business* 83 (November 2003): 18-70.

Nakamura, Leonard. "What is the U.S. Gross Investment in Intangibles? (At Least) One Trillion Dollars a Year!" Federal Reserve Bank of Philadelphia Working Paper, 01-15, October 2001.

Organisation for Economic Co-operation and Development (OECD). *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*. Paris: OECD Publications, 2002.

Organization for Economic Cooperation and Development. *Handbook on Deriving Capital Measures of Intellectual Property Products*. Paris: OECD Publications, December 2009.

Robbins, Carol A., and Carol E. Moylan. "Research and Development Satellite Account Update: Estimates for 1959–2004 and New Estimates for Industry, Regional, and International Accounts." *Survey of Current Business* 87 (October 2007): 49–92.

Robbins, Carol A., Felicia V. Candela, Mahnaz Fahim-Nader, and Gabriel W. Medeiros. "Methodology for the Industry Estimates in the 2007 R&D Satellite Account." Bureau of Economic Analysis/National Science Foundation 2007 R&D Satellite Account Background Paper, December 2007

Robbins, Carol. "Measuring Payments for the Supply and Use of Intellectual Property," *In International Trade in Services and Intangibles in the Era of Globalization*, edited by Marshall Reinsdorf and Matthew J. Slaughter, Chicago, Illinois: University of Chicago Press, 2009.

Soloveichik, Rachel. "Artistic Originals as a Capital Asset." Paper presented at the Annual Allied Social Sciences Conference, Atlanta, Georgia, January 3-5, 2010.

Soloveichik, Rachel. "Television Programs as a Capital Asset." Unpublished manuscript, Bureau of Economic Analysis, 2010.

Soloveichik, Rachel. "Books as a Capital Asset." Unpublished manuscript, Bureau of Economic Analysis, 2009.

Sutton, Trevor. "Information Paper: Implementation of New International Statistical Standards in ABS National and International Accounts, Australian Bureau of Statistics, September, 2009

Tomer, John F. *Intangible Capital: Its Contribution to Economic Growth, Well-being, and Rationality*. Northampton, Massachusetts: Edward Elgar Publishing, 2008

Trewin, Dennis. *Australian System of National Accounts: Concepts, Sources and Methods*, Australian Bureau of Statistics, 2000.

Van Ark, Bart and Hulten, Charles. *Innovation, Intangibles and Economic Growth: Towards a comprehensive accounting to the Knowledge Economy*. Economics Program Working Paper EPWP #07-02. New York, New York: The Conference Board, (2007).

van Rooijen-Horsten, Myriam; Dirk van den Bergen; Mark de Haan; Angelique Klinkers and Murat Tanriseven, "Intangible Capital in The Netherlands: Measurement and Contribution to Economic Growth," Paper Prepared for the 30th General Conference of The International Association for Research in Income and Wealth, Portoroz, Slovenia, August 24-30, 2008.

Table I
Intangibles Assets in National Accounts: A County Comparison

Country	Mineral exploration	Software	R&D	Film	TV and radio programs	Literary works	Musical works
United States	X	X					
Australia (1)	X	X	X	X	X	X	X
Canada (2)	X	X					
Finland (3)	X	X		X	X	X	X
Japan (4)	X	X					
Netherlands (5)	X	X		X	X	X	X
United Kingdom (6)	X	X			X	X	X

- (1) Sutton (2009)
- (2) Baldwin, et al. (2008)
- (3) Jalava, et al. (2007)
- (4) Fukao and Hamagata (2007)
- (5) van Rooijen-Horsten (2008)
- (6) Marrano et al. (2007)

Table II
Intangible Investment Share of Unadjusted GDP

	US (2002)	US (1998- 2000)	Australia (2005-2005)	Canada (2005)	Japan (2000- 2002)	Netherlands 2005
Scope of investment covered	private sector	non-farm business sector	market sector	business	industry	commercial sector
Type of Intangible						
Computerized Information	1.7%	1.6%	0.8%	1.0%	2.0%	1.4%
Innovative Property	2.2%	4.5%	2.2%	5.0%	3.7%	1.8%
R&D from business expenditure surveys	1.5%	2.0%	0.8%	1.9%	2.1%	1.0%
Social science R&D, not captured in the line above	0.0%	0.1%	*	1.8%	no estimate	*
Mineral exploration	0.1%	0.2%	0.3%	1.1%	0.0%	
Copyright and license costs	0.4%	0.8%	0.1%	0.1%	0.9%	0.2%
New product development in the financial industry, not captured in business expenditure surveys	no estimate	0.8%	0.1%	0.0%	0.7%	*
New architectural and engineering designs, not captured in business expenditure surveys	0.1%	0.7%	0.1%	0.0%	no estimate	0.6%
Economic Competencies	no estimate	6.9%	2.9%	3.8%	2.5%	5.2%
Intangible investment % of unadjusted GDP	3.9%	13.1%	5.9%	9.8%	8.3%	8.4%
	this study	Corrado, Hulten, & Sichel	Barnes and McClure	Belhoucine	Fukao and Hamagata	van Rooijen- Horsten et al.

* assumed to be included in the scientific R&D survey

Table III: Industry and Commodity List

INDUSTRY		Current COMMODITY		New COMMODITY
NAICS	Description	NAICS	Description	
R&D				
32	Paper, Chemicals, and Mineral Products Manufacturing	3254	Pharmaceutical and medicine manufacturing	R&D services - for sale
		325	Chemicals other than pharmaceutical and medicine manufacturing	R&D service - own account
33	Metals, Machinery, Electrical, Transportation, and Furniture Products Manufacturing	3341	Computer and peripheral equipment manufacturing	
		3342	Communications equipment manufacturing	
		3344	Semiconductor and other electronic component	
		3345	Navigational, measuring, electro-medical, and control manufacturing	
		3343, 3346	Other computer and electronic products manufacturing	
		3364	Aerospace product and parts manufacturing	
		3365	Other transportation equipment manufacturing	
51	Information	5112	Software publishers	
54	Professional, Scientific, and Technical Services	5415	Computer systems design and related services	
		5417	Scientific R&D services	
		5419	Other professional, scientific, and technical services	
	All Other	54XX	other for-profit industries	
61	Educational Services		Colleges and institutions	
	Public Administration		general (Federal) government	
			state and local government	
Entertainment, literary, and artistic originals				
51	Information	5111	Newspapers, periodicals, books, and directory publishers	Film originals own account
		5121	Motion pictures and videos	Television originals own account
		5122	Sound recordings	Literary works own account
		5191	Other information services	Musical works own account
71	Arts, Entertainment, and Recreation	7111	Performing Arts Companies	Musical works for sale
				Photographic originals own account
				Photographic originals for sale
				Performance art own account
Other intellectual property				
54	Professional, Scientific, and Technical Services	5413	Architectural, engineering, and related services	Architectural and engineering design own account
				Architectural and engineering design for sale

**Table IV:
Impact of R&D and Other Intangibles Investment
On Gross Output and Final Uses**

Gross Output (billions of dollars)	
Total commodity output, as published, 2002 benchmark	19,180
Plus own-account business R&D output, adjusted for software overlap	117
Plus CFC on nonmarket R&D assets	73
Less nonmarket purchases of R&D	-75
Plus other own-account innovative property-type intangibles	45
Equals total commodity output, adjusted with R&D as investment	19,341
Impact on gross output	161
Final Uses (billions of dollars)	
Total final uses, as published, 2002 benchmark	10,672
Plus own-account business R&D output, adjusted for software overlap	117
Plus purchased business R&D investment	42
Plus other own-account innovative property-type intangibles	45
Plus purchased intangible investment	7
Plus CFC on nonmarket R&D assets	73
Total final uses, adjusted with R&D as investment	10,957
Impact on final uses and GDP	285

Table V: Private Capital Investment, by Type and Sector, 2002
(millions of dollars)

	Research & Development	Entertainment, Literary, & Artistic	Architectural & engineering design	Total New Intangible Capital	Existing Intangible Capital	Tangible Capital	Intangible Capital as a Percent of Tangible Capital
Agriculture, forestry, fishing and hunting	790.3	-	20.0	810.4	480.9	50,035.5	2.6%
Mining	790.3	-	171.4	961.8	16,580.3	35,929.5	48.8%
Utilities	108.3	-	29.7	137.9	6,192.2	48,569.6	13.0%
Construction	133.9	-	2,130.0	2,263.9	6,814.8	72,075.1	12.6%
Manufacturing	110,442.1	-	387.8	110,829.9	44,678.8	199,172.3	78.1%
Wholesale trade	4,505.4	-	35.6	4,541.0	6,639.6	35,669.8	31.3%
Retail Trade	4,508.6	-	25.0	4,533.6	4,297.1	56,959.5	15.5%
Transportation and warehousing	1,536.2	-	62.0	1,598.2	5,787.1	96,863.2	7.6%
Information	11,319.3	34,994.1	384.4	46,697.8	14,772.8	104,894.8	58.6%
Finance, insurance, and real estate	1,553.7	-	317.6	1,871.3	24,746.5	290,389.2	9.2%
Professional and managerial services	29,539.0	1,579.5	6,138.0	37,256.5	53,414.8	40,451.9	224.1%
Educational services and health care	1,510.9		31.6	1,542.5	10,392.4	72,069.9	16.6%
Arts, entertainment, recreation, accommodation, and food service	-	4,590.8	28.8	4,619.6	1,676.4	40,988.7	15.4%
Other services, except government	37.6	-	16.3	53.9	1,676.4	41,581.1	4.2%
Total	166,775.7	41,164.4	9,778.4	217,718.3	198,150.0	1,185,650.0	35.1%

**Table VI: Impact of New R&D and Intangible Investment on Sector Value Added, 2002
(millions of dollars)**

	Value Added Without R&D and New Intangibles	Adjusted Value Added	Percent Change in Value Added
Agriculture, forestry, fishing and hunting	95,006.1	95,816.5	0.85%
Mining	91,983.0	92,944.8	1.05%
Utilities	186,737.2	186,875.1	0.07%
Construction	482,698.1	484,962.0	0.47%
Manufacturing	1,280,216.9	1,391,046.8	8.66%
Wholesale trade	597,254.5	601,795.5	0.76%
Retail Trade	663,325.3	667,858.9	0.68%
Transportation and warehousing	286,039.2	287,637.4	0.56%
Information	530,837.4	577,535.2	8.80%
Finance, insurance, and real estate	2,379,929.2	2,381,800.5	0.08%
Professional and managerial services	1,309,831.7	1,342,498.8	2.49%
Educational services and health care	786,110.0	789,204.0	0.39%
Arts, entertainment, recreation, accommodation, and food service	401,350.6	405,983.2	1.15%
Other services, except government	251,057.7	251,742.6	0.27%
Total	9,342,376.9	9,557,701.4	2.30%

Table VII: 2002 Benchmark I-O make table adjusted for intangibles as investment

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
																										Total industry output
1																										
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Note: Both the make and the use table include row and column adjustment factors to account for the reassignment of other commodity output to the R&D commodity that are not shown in this table. The reason for this adjustment is that the published input-output tables for 2002 show some R&D output as other types of commodities. The detailed source data used for BEAs R&D satellite accounts allowed us to make more accurate estimates of R&D output.

Table VIII. 2002 Benchmark I-O use table adjusted for intangibles as investment

		(Millions of dollars)																			
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
		Industries											Information		FIRE		Professional and business services		Educational services and health care		
		Agriculture, forestry, fishing and hunting	Mining	Utilities	Construction	Manufacturing				Wholesale trade	Retail trade	Transportation and warehousing	Software publishers	All other information	Finance and Insurance	Real Estate	Professional and business services	Educational services and health care			
						Chemical manufacturing	Computer and electronics	Transportation equipment	All other manufacturing												
7		Agriculture, forestry, fishing and hunting	72027.7	360.8	0.3	2665.0	1052.3		2.8	144392.2	254.2	1738.2	18.9	0.3	0.0	0.1	1432.6	367.5	275.0		
8		Mining	703.2	8610.7	61790.2	8540.6	3288.0	76.1	971.0	136379.6	83.6	81.1	1188.6	0.5	263.3	7.8	1349.5	278.0	298.5		
9		Utilities	6328.3	5466.2	377.2	4339.7	12916.3	2771.1	4231.2	50092.3	5319.3	14295.3	4152.1	194.2	4774.6	2316.0	18353.2	8385.9	17912.2		
10		Construction	1168.3	6620.7	7234.3	671.7	1721.5	722.6	962.0	8784.5	1092.5	3039.7	4508.3	85.0	5235.0	4600.3	51137.4	2745.8	2673.3		
11		Manufacturing	40493.5	17120.3	8462.8	232212.6	153911.0	111815.9	324935.3	746644.9	41000.5	62197.4	65535.6	2512.2	51880.5	12712.1	44140.1	63162.7	111887.7		
12		Wholesale trade	10469.1	2584.1	1349.1	27202.5	20784.7	24980.5	30644.1	115429.4	28143.6	15039.5	8456.4	1753.3	5280.1	1624.1	11320.7	7985.4	18859.7		
13		Retail trade	226.7	434.2	60.8	46777.5	2050.500001	269.9	2937.4	3897.3	847.8	2487.7	2409.4	10.3	177.4	357.9	8443.2	911.1	2268.4		
14		Transportation and warehousing	6872.7	3696.4	22504.5	16435.0	8659.8	3579.6	9287.3	66954.8	28448.2	28967.4	69044.1	1025.0	11203.8	9240.9	4277.1	21178.9	10531.7		
15		Information	383.1	593.3	1106.7	8523.6	1232.7	15205.2	2528.1	13016.0	8561.1	11467.5	6438.7	3067.3	128273.4	23417.8	5954.5	51625.6	18820.9		
16		Finance, insurance, real estate, rental, and leasing	29994.4	23412.9	8696.1	34706.5	8718.0	9754.2	9154.4	63401.0	44753.4	95289.2	48683.7	7544.8	44260.6	404019.3	264325.9	142059.4	142576.0		
17		Other Non-R&D	4103.9	21298.1	13216.4	83977.0	58450.8	46474.8	49888.3	194843.2	98339.5	91109.9	58574.9	21182.6	91913.5	117960.9	91329.2	264570.0	123294.5		
18		R&D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
19		Junior colleges, colleges, universities, and professional schools	1026.2	0.5	88.5	0.0				7.0	56.8	0.0	18.2		321.7			0.5	125.9		
20		all other Educational services, health care, and social assistance	0.0	0.0	40.9	39.4	1.6	3.5	3.0	68.8	369.9	2036.9	46.3		81.2	72.0	0.6	490.3	20811.0		
21		Arts, entertainment, recreation, accommodation, and food services	315.3	237.8	3909.7	3178.0	965.2	991.8	1407.8	13659.3	4470.5	5636.9	5211.0	1808.0	17704.7	17805.9	6501.2	40714.0	13717.3		
22		Government	69.8	12.9	268.5	52.6	306.5	73.0	100.3	1854.7	7302.6	6889.1	13010.4	148.9	3575.4	3062.3	3453.4	5965.1	7232.8		
23		Other services, except government	1266.4	373.1	727.4	15049.5	2528.2	1209.7	1679.6	14599.1	6725.3	7513.9	5825.6	409.2	7585.4	12165.4	15350.6	20433.7	12985.3		
24		Scrap, used and secondhand goods	-14.3	23.9	54.3	88.4	116.9			11720.8	1.7	603.7	1045.0		76.6	0.3	-784.4	510.0	87.0		
25		Other inputs	97.4	971.4	488.9	266.5	5452.8	1949.5	3488.7	6141.2	7387.8	485.8	16130.4	1744.0	9470.1	19202.4	2140.2	7578.4	32.1		
26		Total intermediates	Adjusted with intangibles	175327.3	92171.3	131573.5	482727.1	282513.9	224060.5	441119.2	1591995.8	286124.4	348016.5	310039.4	41163.1	381749.6	628943.6	528800.6	632797.7	505847.3	
27			Unadjusted (without intangibles)	175558.7	92554.1	131632.1	484892.9	297711.4	228419.2	445744.8	1601576.9	287364.7	349249.5	310531.9	41759.5	382882.3	629462.2	529015.1	636850.0	506701.9	
28		Value added	Value added change due to R&D	790.3	790.3	108.3	133.9	29456.1	39699.0	21284.2	20002.9	4505.4	4508.6	1536.2	8045.0	3274.3	1217.0	336.6	14579.1	3061.9	
29			Value added change due to intangible Assets	20.0	171.4	29.7	2130.0	0.0	0.0	0.0	387.8	35.6	25.0	62.0	384.4	34994.1	317.6	0.0	7717.2	31.6	
30		Compensation of employees	31837.9	28685.6	56975.5	368238.7	59872.0	83746.1	115045.2	506333.1	323240.9	376391.0	202719.7	42114.6	204219.3	461747.2	85008.9	893162.8	656656.1		
31		Taxes on production and imports, less subsidies	-3238.8	13531.7	36177.2	5386.8	2202.5	1143.6	1675.4	27532.6	142854.8	133420.9	12527.0	1556.6	38863.4	37351.9	188481.9	23917.3	11529.8		
32		Gross operating surplus	66407.0	49765.7	93584.5	109072.6	88268.6	41140.1	62807.9	290449.8	131158.8	153513.4	70792.5	26167.3	217916.2	379843.6	1227495.7	333320.7	118924.1		
33		Total Value added	Adjusted with intangibles	95816.5	92944.8	186875.1	484962.0	179799.2	165728.8	200812.7	844706.2	601795.5	667858.9	287637.4	78267.9	499267.3	880477.3	1501323.1	1227697.1	789203.5	
34			Unadjusted (without intangibles)	95006.1	91983.0	186737.2	482698.1	150343.1	126029.8	179528.5	824315.5	597254.5	663325.3	286039.2	69838.5	460998.9	878942.7	1500986.5	1250400.8	786110.0	
35		Industry output	Adjusted with intangibles	271143.8	185116.1	318448.6	967689.1	462313.1	389789.2	641931.9	2436702.0	887919.8	1015875.4	597676.8	119431.0	881016.9	1509420.9	2030123.7	1905494.8	1295050.8	
36			Unadjusted (without intangibles)	270564.8	184537.1	318369.3	967591.0	448054.5	354449.0	625273.3	2425892.4	884619.2	1012574.8	596571.1	111598.0	843881.2	1508404.9	2030001.6	1887250.8	1292811.9	

Note: Both the make and the use table include row and column adjustment factors to account for the reassignment of other commodity output to the R&D commodity that are not shown in this table. The reason for this adjustment is that the published input-output tables for 2002 show some R&D output as other types of commodities. The detailed source data used for BEA's R&D satellite accounts allowed us to make more accurate estimates of R&D output.

Table VIII: 2002 Benchmark I-O Use table adjusted for intangibles as investment

(Millions of dollars)

W		X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP
Arts, entertainment, recreation, accommodation, and food service		Government			Total intermediates		PCE	Gross private fixed investment				Change in private inventories	Exports of goods and services	Imports of goods and services	Government investment	Government consumption	Sum of final uses		Commodity output	
Performing arts and independent artists	All other	General Federal	Public Higher education	Other services, except government	Adjusted with intangibles	Unadjusted (without intangibles)		Gross Private Fixed Investment	Intangible assets	R&D	Adjusted with intangibles						Unadjusted (without intangibles)	Adjusted with intangibles	Unadjusted (without intangibles)	
0.0	4180.2	1612.6	76.2	95.0	230807.5	230827.5	48655.1	0.0	20.0	0.0	-3756.4	20975.9	-24884.8	0.0		40909.8	40889.8	271717.3	271717.3	
2.7	339.7	7896.2	14.0	178.4	232237.4	232408.8	118.3	30444.1	171.4	0.0	-2781.9	3768.2	-93985.2	0.0		-62265.1	-62436.5	169972.3	169972.3	
82.6	16563.5	28579.3	2297.5	5331.6	215920.8	215950.4	171307.3	0.0	29.7	0.0	0.0	524.3	-1201.2	0.0		170660.1	170630.4	386580.8	386580.8	
20.4	2747.7	41872.1	615.8	2646.0	150997.4	153127.4	0.0	662526.2	2130.0	0.0	0.0	65.7	0.0	216627.6		881349.5	879219.5	1032346.9	1032346.9	
453.6	76514.5	187135.8	12966.0	36368.1	2392215.1	2392602.9	1248059.2	565745.3	387.8	0.0	13781.4	495414.9	-1014741.4	84363.9		1393011.1	1392623.3	3785226.2	3785226.2	
98.9	13128.8	27342.1	2028.2	5899.3	380615.4	380651.0	303995.4	86311.6	35.6	0.0	2288.1	68164.4	19917.0	9658.6		490370.7	490335.1	870986.1	870986.1	
71.3	1892.7	271.7	9.3	4853.8	81132.1	81157.1	789492.3	37103.4	25.0	0.0	0.0	0.0	0.0	0.0		826620.7	826595.7	907752.8	907752.8	
393.8	7613.5	35568.0	2156.4	7092.2	376985.0	377046.9	161939.0	19459.6	62.0	0.0	207.9	58334.2	-12102.2	1939.4		229839.9	229777.9	606824.8	606824.8	
411.5	8290.6	53624.8	4972.8	9696.7	378230.3	378642.2	311503.2	59242.4	36612.0	0.0	-206.2	26305.4	-3597.6	6928.7		436787.9	400175.9	815012.6	778818.1	
1353.0	54293.7	60711.4	850.7	72769.4	1578604.4	1578922.0	1845786.9	70858.0	317.6	0.0	0.0	80157.8	-27142.3	0.0		1969978.0	1969660.4	3548582.4	3548582.4	
4682.9	75651.7	198292.2	10828.0	42025.1	1769967.4	1771914.4	150064.0	159571.5	7911.7	0.0	0.0	48695.8	-7941.6	21369.6		379671.0	371759.3	2149638.4	2143673.7	
0.0	0.0	0.0	0.0	0.0	-18100.9	116808.6	0.0	0.0	0.0	166776.6	0.0	8156.1	-3028.0	74575.7	0.0	246480.4	9717.2	228379.5	126525.8	
		9012.5		11.1	10668.9	-10668.9	-298.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0		-298.7	0.0	10370.2	10668.9	
24.3	380.8	8629.0	153.2	1675.6	19563.4	22334.5	1403815.1	0.0	31.6	0.0	0.0	702.9	-494.9	0.0		1404054.7	1399434.0	1423618.2	1421768.5	
3776.9	15680.9	20301.2	3125.0	6355.9	188667.8	188686.1	571255.3	0.0	3191.9	0.0	0.0	603.0	-110.0	0.0		574940.2	571745.8	763608.0	760431.9	
59.0	7542.1	9241.8	590.9	2444.9	59898.8	43171.0	47774.0	0.0	1373.1	0.0	0.0	237.6	0.0	20726.2	1605416.4	1675527.3	1680821.9	1735426.1	1723992.9	
174.0	7867.1	24579.4	1912.8	5986.1	167077.0	166569.2	401904.5	0.0	16.3	0.0	0.0	141.4	-1871.9	0.0		400190.3	400067.1	567267.3	566636.3	
80.0	248.2	-2.5		1910.6	15766.2	15766.2	68345.9	-85528.3	0.0	0.0	4142.3	7692.3	-8041.3	2837.7		-10551.4	-10551.4	5214.8	5214.8	
20.7	367.1	16774.4		54.6	101154.5	101154.5	-35665.1	2757.8	0.0	0.0	0.0	89812.4	-158059.6	0.0		-101154.5	-101154.5	0.0	0.0	
11708.9	293821.1	716141.9	42795.2	205666.3																
11708.9	293846.6	773791.7	42993.3	205720.2																
0.0	13.0	67908.0	0.0	668.6																
0.0	4619.6	1373.1	0.0	16.3																
9133.8	246245.4	1035788.9	98833.0	156242.5																
897.1	49375.7	-12393.4		10948.9																
12013.9	83684.7	198345.9	8948.0	83866.3																
22044.8	383938.4	1291022.5	107781.0	251742.6												10956505.6				
22044.8	379305.8	1221741.4	107781.0	251057.7													10671899.2			
33753.7	677759.5	2007164.4	150576.2	457408.9														19340844.9		
33753.7	673155.7	1995731.2	150576.2	456777.9															19180035.2	