The United States Research and Development Satellite Account: Estimates and Challenges

Brent R. Moulton

National Academies - STEP - Intangible Assets Conference
Washington, June 23, 2008
Overview

- Motivation
- Conceptual challenges for measuring R&D investment
- Overview of the estimation process
- Results from September 2007 release
- Next steps: Toward an innovation account
Why measure expenditures on intangibles as capital formation?

**Economic theory:**
- Expenditures on tangible and intangible assets that reduce current consumption and increase future output should be treated as capital formation.

**National accounting consistency**
- Many intangible expenditures have the qualities of produced assets

**Improved measurement of intangibles important for:**
- Improving accuracy of GDP estimates
- Developing quantitative measures of innovation
- Identifying sources of economic growth
Conceptual Challenges

- Definition of the unit of R&D output
- R&D output price index
- Depreciation and obsolescence
- Public goods qualities of R&D
NSF Time Series of R&D Expenditure Data

- National Science Foundation Survey of Industrial R&D
  - Over 50 years of industry-level R&D expenditure data
  - Data on costs for employees, materials, and depreciation
  - Focus on R&D in physical and life sciences and engineering

- BEA-NSF collaboration on R&D satellite Account

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**Challenge: R&D Price Index**

- **Purchase price of the original**
  - Limited transactions data, and no unit of output
- **Comparable Market Approach**
  - Purchase price of substitutes or similar products are also hard to identify
- **Income or Net Present Value**
  - Difficult to estimate future income generated by the R&D and income generated by other factors
- **Aggregate R&D input price index**
  - Weighted combination of input prices
  - Tracks with GDP deflator (green line)
- **Aggregate R&D output price index**
  - Uses BEA industry output prices, (based on producer price indexes)
  - Weighted by R&D investment by R&D intensive industries
Challenge: Depreciation estimates for R&D assets

- Consumption of fixed capital (economic depreciation) measures the value of the capital used up in production
  - Wear and tear for tangibles
  - Obsolescence and “leaking out” for intangibles

- R&D assets: Currently using averages from academic literature:
  - Chemical manufacturing, including pharmaceutical and medicine manufacturing: 11% per year
  - Transportation equipment manufacturing: 18% per year
  - Computer equipment manufacturing: 16.5% per year
  - All other industries, government, and non-profit R&D investment, including colleges and universities: 15% per year
Non-rivalry affects R&D within multi-unit firms

- How to value R&D shared between:
  - Units in different business segments
  - Units in different states
  - Units in different countries

- Preliminary discussions:
  - “The Treatment of International Research and Development as Investment,” Daniel Yorgason


  - “Issues Related to treating R&D as investment in BEA’s regional accounts,” G. Andrew Bernat

Construction of R&D Satellite Account

 Estimates of R&D capital stock and investment flows based on funder:

 - Private
  - Business
  - Universities and colleges
  - Other Non-profits

 - Government
  - Federal Government extramural
  - Federal Government intramural
  - State and Local governments, excluding universities and colleges
  - Universities and colleges
Overview of Estimate Construction

- Current dollar investment: sum input costs from NSF survey data
- Deflate current dollar investment
- Create capital stocks with perpetual inventory method: cumulative R&D investment less R&D depreciation
- For government and non-profit institutions: include a return to R&D
- Recalculate GDP and other macroeconomic variables
Results from BEA’s 2007 R&D Satellite Account:

- Between 1959-2004, R&D accounted for 5 percent of growth in real GDP
- Between 1995-2004, R&D’s contribution rose to 7 percent
  - In comparison, business gross fixed capital formation in commercial and all other types of buildings accounted for just over 2 percent of real GDP growth.
- R&D’s stepped-up contribution is almost as large as the contribution of computers in the existing GDP measure.
Addition to GDP from R&D Investment

$Billion


Business R&D Nonprofit R&D Government R&D

current dollar

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Top Four Private Business R&D-investing Industries

[% of Private Business Investment in R&D]

1987
- Motor Vehicles 11.4%
- Aerospace 11.0%
- Semiconductors & electric components, 9.4%
- Pharmaceuticals 8.0%
- Software publishers 8.1%
- 60.2%

2004
- Pharmaceuticals 20.0%
- Semiconductors & electric components, 8.8%
- Motor Vehicles 8.3%
- 54.6%*

*Does not sum to 100% due to rounding errors
## Industry Impacts: Average Percent Change in the Level of Value Added, 1987-2004

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmaceutical and medicine mfg</td>
<td>38.4</td>
</tr>
<tr>
<td>Chemicals minus pharmaceutical and medicine mfg</td>
<td>7.9</td>
</tr>
<tr>
<td>Computer and peripheral equipment mfg</td>
<td>29.8</td>
</tr>
<tr>
<td>Communications equipment mfg</td>
<td>22.1</td>
</tr>
<tr>
<td>Semiconductor and other electronic component mfg</td>
<td>25.7</td>
</tr>
<tr>
<td>Navigational, measuring, electro-medical, and control instruments mfg</td>
<td>12.2</td>
</tr>
<tr>
<td>Other computer and electronic products mfg</td>
<td>9.1</td>
</tr>
<tr>
<td>Motor vehicles, bodies and trailers, and parts mfg</td>
<td>14.5</td>
</tr>
<tr>
<td>Aerospace product and parts mfg</td>
<td>14.3</td>
</tr>
<tr>
<td>Other transportation equipment mfg</td>
<td>4.1</td>
</tr>
<tr>
<td>Software publishers</td>
<td>14.2</td>
</tr>
<tr>
<td>Computer systems design and related services</td>
<td>2.4</td>
</tr>
<tr>
<td>Scientific R&amp;D services</td>
<td>12.7</td>
</tr>
<tr>
<td>All other industries</td>
<td>0.7</td>
</tr>
</tbody>
</table>

*current dollar*
Conclusion: What’s Next?

- R&D in an Input-Output framework
- Regional and international aspects of R&D as investment
- Developing more timely indicators of R&D investment
- Prototype Innovation Account
Expanded measurement of intangibles - Candidates for innovation satellite account

Research and Development (R&D): Spending on scientific and engineering R&D
- Product and process innovation
- More timely data and more frequent indicators
- Receipts (royalties and license fees) as well as expenditures
- Associated capital investment expenditures
- Someday: Valuation of Intellectual Property

Expenditures on Design and Development (D&D): Spending on social science design and development of new products and processes.
- Expanded sample frame
- Explicit subcategories for:
  - Industrial product and process design and development
  - Artistic and entertainment product and process design and development

Human Capital: Employer spending on employee training and development

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For more information

Detailed information on the R&D satellite account is available at:

http://www.bea.gov/national/index.htm#researchand development