Measuring U.S. Innovative Activity

NSF/SRS Workshop on

Advancing Measures of Innovations:

Knowledge Flows, Business Metrics, and Measurement Strategies

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The views expressed in this presentation are those of the author and not necessarily those of the U.S. Census Bureau.

Overview

Importance of Measuring Innovative Activity

Allocating Scarce Statistical Resources

Definitions

U.S. Innovation Measurement

Measuring U.S. Innovative Activities

Innovation Measurement Elsewhere

Issues for the U.S.

Innovative Activities: Potential Sources of Productivity and Growth

Complementary to R&D, traditional production function inputs

Importance may shift over time

Related concept: Intangible capital

Scarce Statistical System Resources

Dollars

Expertise / core competencies

Respondent burden / cooperation

Gaps in core data

Innovation: Developing Definitions

OECD “Oslo” Innovation Manual

Guidelines for Collecting and Interpreting Innovation Data

1992 / 1997 / 2005 editions

163 pages in 2005 edition

Related but different idea: Research and Development (R&D)

OECD “Frascati” R&D manual 1963 / 1993 / 2002

Oslo Manual Definitions 1

Innovation:

> *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*
>
> 2005 version, p. 46.

Oslo Manual Definitions 2

- Distinguishes among types of innovations
  - Product, process
  - Marketing, organizational – new to 2005 definition
- Changes are not considered innovations
- Novelty and diffusion
- Innovative firms

Prior U.S. Innovation Measures: U.S. Statistical System 1

1953 – Present: NSF-sponsored R&D Survey

- NSF charged with responsibility for developing U.S. R&D statistics
- NSF contracts with Census Bureau to collect the Industrial Research and Development Survey
  - Current coverage: publicly traded and privately-owned, nonfarm business firms in all economic sectors
  - Annual since 1953
  - Response rate since mid 1990s: 80% - 85%

Prior U.S. Innovation Measures: U.S. Statistical System 2

1980s: Attempt to define "high tech" industries – McGuckin *et al.* paper

1988 & 1993: Survey of Manufacturing Technologies

1995: Manufacturer's Innovation Survey Pilot

NSF-sponsored

Prior U.S. Innovation Measures: U.S. Statistical System 3

National Employer Surveys (NES): 1994, 1996, 1997, 1998, 2000

Computer Network Use Survey (CNUS): 1999 supplement to the Annual Survey of Manufactures

Information and Communications Technology (ICT): 2003, 2004 Supplements to Annual Capital Expenditure Survey (ACES)

Entrepreneurship: Integrated Longitudinal Business Database (ILBD), Characteristics of Business Owners Survey (CBO)

Worker and Firm Characteristics: Longitudinal Employer-Household Dynamics (LEHD)

Prior U.S. Innovation Measures: Private

1982, 1986: NSF-sponsored manufacturing innovation survey

2001-2002: NSF-sponsored *Information Technology Innovation Survey: Fall 2001* (IBM Business Consulting Services)

Many historical and current private surveys – overview in NRC 2005

U.S.: Lessons Learned 1

- Census Bureau: Center for Economic Studies (CES) and the Research Data Center (RDC) Program
- CES staff conducts research on micro databases it develops from Census Bureau business and household data collections
- RDCs offer qualified researchers restricted access to selected Census Bureau data under certain conditions:
  - www.ces.census.gov
  - See appendix to this presentation
- Most but not all U.S. lessons learned in this presentation are result of CES or RDC research

U.S.: Lessons Learned 2

1995: NSF Manufacturer's Innovation Survey Pilot, 1000 firms

- Based on Oslo Manual
- Low overall response rates-- 45% - 53%
  - Far below other Census Bureau surveys of firms
  - Voluntary survey –response rates tend to be lower than for mandatory surveys
- Not linked to other surveys so can't follow through R&D / innovation / diffusion cycle
- **Major issue**: Lower response rates for <u>larger</u> firms
  - Large firms more likely to report innovative activity
  - National Bureau of Economic Research (NBER) researchers recommended not conducting further surveys

U.S.: Lessons Learned 3

1999: Computer Network Use Survey (supplement to the Annual Survey of Manufactures); 55,000 plants

83% response rate; mandatory survey

Strong empirical links between productivity and

- Computer network use
- Sophisticated enterprise software use
- Intensity of network use, and how used
  - Supply chain activities important, production not

U.S.: Lessons Learned 4

2002: NSF Innovation Survey

- 4,000 companies
  - Based on Oslo Manual
  - 2 sectors: producers and users of IT-based innovation
  - Low response rate – 57%
    - Well below current draft OMB guidelines
    - Voluntary survey
  - IT significant or critical component of product and process innovation

Source: Information Technology Innovation Survey: Fall 2001 (IBM Business Consulting Services)

U.S.: Lessons Learned 5

2003 & 2004 ACES ICT Supplement:

Important to collect noncapitalized spending

	2004 ICT Spending	
Category	Capitalized	Noncapitalized
	(Billion dollars)	
Computer & Peripheral Equipment	$52.7	$25.7
ICT Equipment	$29.2	$11.3
Software	$52.9	$53.7
Electromedical & electrotherapeutic apparatus	$ 4.5	$ 1.9

Note: Companies with employees

Source: U.S. Census Bureau, 2006, *Information and Communication Technology: 2004*.

U.S.: Lessons Learned 6

ILBD: Employer and Non-Employer Businesses Davis, Haltiwanger, Jarmin, Krizan, Miranda, Nucci, Sandusky 2006

Small but important fraction (5%) of non-employer businesses related to employer businesses

Businesses that transition from non-employer to employer grow more rapidly before transiting than other non-employers

Many employers have no history as non-employers

Growth of young and small businesses is volatile

U.S.: Lessons Learned 7

NES 1994, 1996, 1997, 1998

Response rates 60% - 84%

- Vary by year, sector, size of employer

Voluntary survey -- 3,000 to 5,500 businesses

Data on

- Employees, employee training
- Business characteristics, including management practices
- Equipment and technology

Can be linked to Census Bureau employer data series

U.S.: Lessons Learned 8

NES

Productivity positively linked to investments in human capital, hiring better-educated workers Black&Lynch *Review of Economics and Statistics* 2001

Workplace organization – re-engineering, teams, incentive pay, employee voice –

- linked to multi-factor productivity growth Black&Lynch *Economic Journal* 2004
- raises labor costs per employee Cappelli & Neumark *ILRR* 2001
- statistically weak link to higher productivity Cappelli & Neumark *ILRR* 2001
- little effect on overall labor efficiency Cappelli & Neumark *ILRR* 2001
- raise output per dollar spent on labor Cappelli & Neumark *ILRR* 2001

U.S.: Lessons Learned 9 Committee on National Statistics 2005

Conclusion: Innovation, linked activities, and outcomes can be measured

Many lessons still to be learned

- Period of observation
- Appropriate Unit of observation – firm or plant?
- Sectors covered
- "Entry level" question in Oslo manual, "new to firm," can yield very high innovation rate
- Measuring "world first" and "market first"
- Nontechnological innovation, e.g. supply chain management

U.S.: Lessons Learned 10 Committee on National Statistics 2005

Recommendations to NSF:

Resolve methodological issues related to collecting innovation-related data

- Data collection should be integrated with or supplemental to the R&D survey
- Work with experts in universities & public institutions

Initiate regular and comprehensive program of measurement and research related to innovation

Innovation Measurement in Other Countries 1

Community Innovation Survey (CIS)

- Eurostat sponsored (required of EU countries)
- 1992, 1996, 2001
- Based on Oslo manual
- CIS 2002/2003 enterprise-level, voluntary, no harmonized questions or methods
- *European Innovation Scorecard* publication

Innovation Measurement in Other Countries 2

Response Rates to Third CIS 2001:

96%:	Norway
73%:	Spain
63%:	France
62%:	Italy
40% - 60%:	Netherlands Finland, Sweden Belgium, U.D., Denmark, Greece, Austria
21%:	Germany

Innovation Measurement in Other Countries 3

- Canada: 1993, 1996, 1999 Survey of Innovation
  - 1993, 1999 also survey advanced technologies and practices, not consistent over time
  - Based on Oslo manual
  - Response rates in 70% range
  - Decade of research links innovation measures with economic inputs, outcomes
  - http://www.statcan.ca/english/freepub/11-623-XIE/2003001/innov.htm
  - *Innovation Analysis Bulletin* publication

Innovation Measurement in Other Countries 4

Australia:

- Innovation surveys 1992-1993, 1996-1997, 2003-2004
  - 2003-2004 not based on CIS
  - Asked three simple questions on innovation
- Initiated series of related measures -- *Measures of a Knowledge-Based Economy and Society, Australia* 2003

Innovation Measurement in Other Countries 5

Japan 2003:

- Innovation survey based on CIS
- Response rate: 21%

What Do the International Data Tell Us? 1 – Aggregate statistics

European Innovation Scoreboard Metrics

- 24 indicators, including:

Education

Employment in medium – high tech manufacturing

Public and Business R&D / GDP

Patent statistics

Venture capital

ICT expenditures

Innovation

What Do the International Data Tell Us? 2 – Aggregate statistics

"Summary Innovation Index"

aggregates Scoreboard measures 1996-2003

60% - 80%:	U.S.
70%:	Japan
40%:	EU countries

What Do the International Data Tell Us? 3 – Micro data analysis

France: R&D and innovation are separate inputs into production process

Mairesse and Mohnen

- 2002 May *American Economic Review*
- 2004 NBER summer meetings

Hall and Mairesse 2006 *Economics of Innovation and New Technology*

Is there a “best practice”?

Current “State of Art” Not Settled:

- Australia’s indicators and structures
- EU-like CIS: Empirical and econometric properties of innovation data being tested

Can CIS be applied straightforwardly to U.S.?

- Different innovation policies / strategies
- Different structures of firms, degree of FDI, etc.
- Different statistical structures, e.g.
  - Single centralized one in most countries
  - Existing U.S. establishment surveys and censuses overburdened

Issues for the U.S.

Does evidence support attempting to collect innovation metrics?

Can the U.S.

- Apply existing “best practice”
- Resolve significant outstanding methodological issues
- Find resources needed
- Identify other key metrics needed to
  - Assess readiness to innovate
  - Follow diffusion of innovative activity
  - Assess impacts

Methodological Issues: Applicability

Differences in economic structure

Differences in sizes of firms

- U.S. has many large multi-unit firms
- Multi-units account for large share of U.S. economic activity

Methodological Issues: Reporting Unit

- Best reporting unit is one that can answer question
  - Accounting conventions
  - Recordkeeping practices
- Best unit for innovation may not be same as best unit for other topics
- Best respondent in a unit may differ for innovation vs. other topics, such as sales
  - HR manager vs. plant manager vs. technical development manager

Methodological Issues: Response Rate

Survey response rates for current federal surveys (2001 OMB study) –

- > 80% for 67% of surveys
- > 70% for 80% of surveys

OMB Guidance, 2006: Nonresponse bias analysis needed if expected unit response rate < 80 %.

Innovation survey rates below these targets -- 50% range for most countries

Methodological Issues: Survey Questions

- Developing and pretesting survey questions
  - Critical to collecting quality data
  - Needs adequate funding and lead time
- Other countries' surveys have lengthy questionnaires
- Some countries' recent collections moved away from Oslo manual

Potential U.S. Next Steps 1

- NSF responsible for measuring U.S. innovative activity
- Redesign of existing mandatory R&D Survey
  - NSF funds survey

Potential U.S. Next Steps 2

- Improve core U.S. statistics needed to analyze productivity, employment, other key outcomes
  - Gaps in key measures of inputs, outputs
    - Services statistics
    - Capital
- Try other routes for understanding innovation, e.g., case studies

Potential U.S. Next Steps 3

Leverage existing statistical assets by more links among micro data sets, such as

U.S. Patent Data & R&D survey

-- NSF-sponsored linkage project underway

FDI / DIA & R&D survey

-- successful 2005 NSF / BEA / Census pilot

Appendix: The Census Bureau Research Data Center Program

Purpose

Research Data Centers (RDCs) offer qualified researchers restricted access to confidential economic and demographic data collected by the Census Bureau in its surveys and censuses. RDCs are established through *partnerships* with academic and similar organizations.

RDC Locations

Ann Arbor MI
Berkeley CA
Boston MA
Chicago IL
Ithaca NY
New York NY
Los Angeles CA
Research Triangle NC
Upper Marlboro MD

RDCs are Census Bureau facilities staffed by a Census Bureau employee and meet all physical and computer security requirements for restricted access

Datasets Available at RDCs

Most Economic Censuses and Surveys

Selected Demographic Surveys and Decennial Censuses

Special Files crated for research purposes:

Longitudinal Research Database, Integrated Longitudinal Business Database, linked files (e.g., LEHD), etc.

RDCs: Title 13 and Title 26

Our legal authority to provide access to these data require that there be a legitimate Title 13, Chapter 5 purpose to any research.

Our legal authority to provide access to IRS (Title 26) data in our custody requires that the Title 13 benefit be the “predominant purpose”.

RDCs: Review and Approval Process

1. Researcher interacts with an RDC Administrator to gather information about the data available and the procedures to be followed.
2. Proposals are submitted for review by Census Bureau staff and are either approved or denied. If denied, they can be resubmitted if they are revised to address noted deficiencies.

RDCs: Review and Approval Process, continued

3. If approved by the Census Bureau, the proposal must also be approved by the agency "owning" the data (e.g., IRS or the survey sponsor).

4. If the requested data set is not available, the proposer can agree to fund the extra work to make that data set available. They can also link external data to Census Bureau data.

RDC Contacts

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