Measuring Science, Technology, and Innovation: A Review
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Overview

- Desirable characteristics of indicators
  - How are they to be used?
  - Data collection and quality issues
- Framework for the STI system
- Existing US indicators and gaps
- Policy uses of indicators
Uses of STI indicators

- Performance assessment and benchmarking
- Informing public policy decisions
- Informing private sector decisions
- Academic research
  - Micro-level information desirable
  - Matched to firm and individual data
Data collection

- Passive - lower respondent burden, less gaming:
  - As a by-product of other activities (e.g., accounting data)
  - Via public sources or web-scraping (e.g., patent data)

- Active - higher respondent burden but possibly better targeted:
  - Surveys – government or private
Data quality

- From Griliches (1986)
  - **Extent** – how long collected, how broad is coverage, etc.?
  - **Reliability** – signal-to-noise in the data, would it be reproducible?
  - **Validity** – relevance and representativeness
  - Added to this list by the *Capturing Change* report – **Accessibility**
Resource, knowledge and outcomes in the innovation system

(1) Government

(2) Education sector; Govt and

(3) Knowledge (not embodied in people)

(4) Human capital

(5) public-private partnerships

(6) ind.-univ. collaboration

(7) Industry

R&D

firm

firm

Industry 1

Industry 2

Funding

Knowledge

Commercial Innovation

(8) TFP; output growth; welfare

(9) Venture capital and other
Growth accounting framework

**Very** simplified model:

\[ g_Y = \alpha g_C + \beta g_L + \gamma g_K + e \]

- \( Y \) = output, \( C \) = physical capital, \( L \) = labor input
- \( K \) = a measure of knowledge assets
- \( g \) = growth rate
- \( e \) = any output growth that cannot be explained by the inputs.

**Measuring \( \alpha, \beta, \gamma \):**

- Growth accounting – assume normal returns and estimate by shares of output (the *input cost* approach)
- Micro-econometric – estimate via a production function (the *output contribution* approach)
Limitations of growth accounting

- Assumes normal rates of return – is this appropriate for intangible inputs like R&D?
- Omits unpriced output (e.g., health and environmental improvements)
- A black box - obscures the function of the underlying STI system
- Linear versus feedback (chain link) model
  - Inputs are things subject to policy intervention
  - Outputs, less so, and rather unpredictable
Current US indicator coverage

• Resource flows well covered, with breakdowns into source and use of funds
  ◦ Flows within sectors less well measured
  ◦ Non-R&D inputs not measured

• Human capital formation and knowledge output also measured fairly well, but proxies may be distant from the underlying concept
  ◦ E.g., counts of degrees, papers, patents, etc.

• Innovation output or success much less well measured; fewer if any indicators
Gaps in US STI indicator coverage

- Innovation, at least until recently
- Service sector
- Non-R&D inputs to innovation
- Timeliness
- Linkages (networks, licensing, JVs, etc)
- Knowledge advance in non-GDP areas
- Capital for financing innovation (angel finance, private equity?)
- Exports and imports – that is, allocation of value added
STI Indicators for policy

- Overall level of public investment in R&D
- Overall level of public investment in education and training
- Allocation of both by scientific or technological fields
- Allocation of public R&D investment by performer
- S&T policy choices beyond spending
- Immigration policy
- Indicators for universities and firms