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

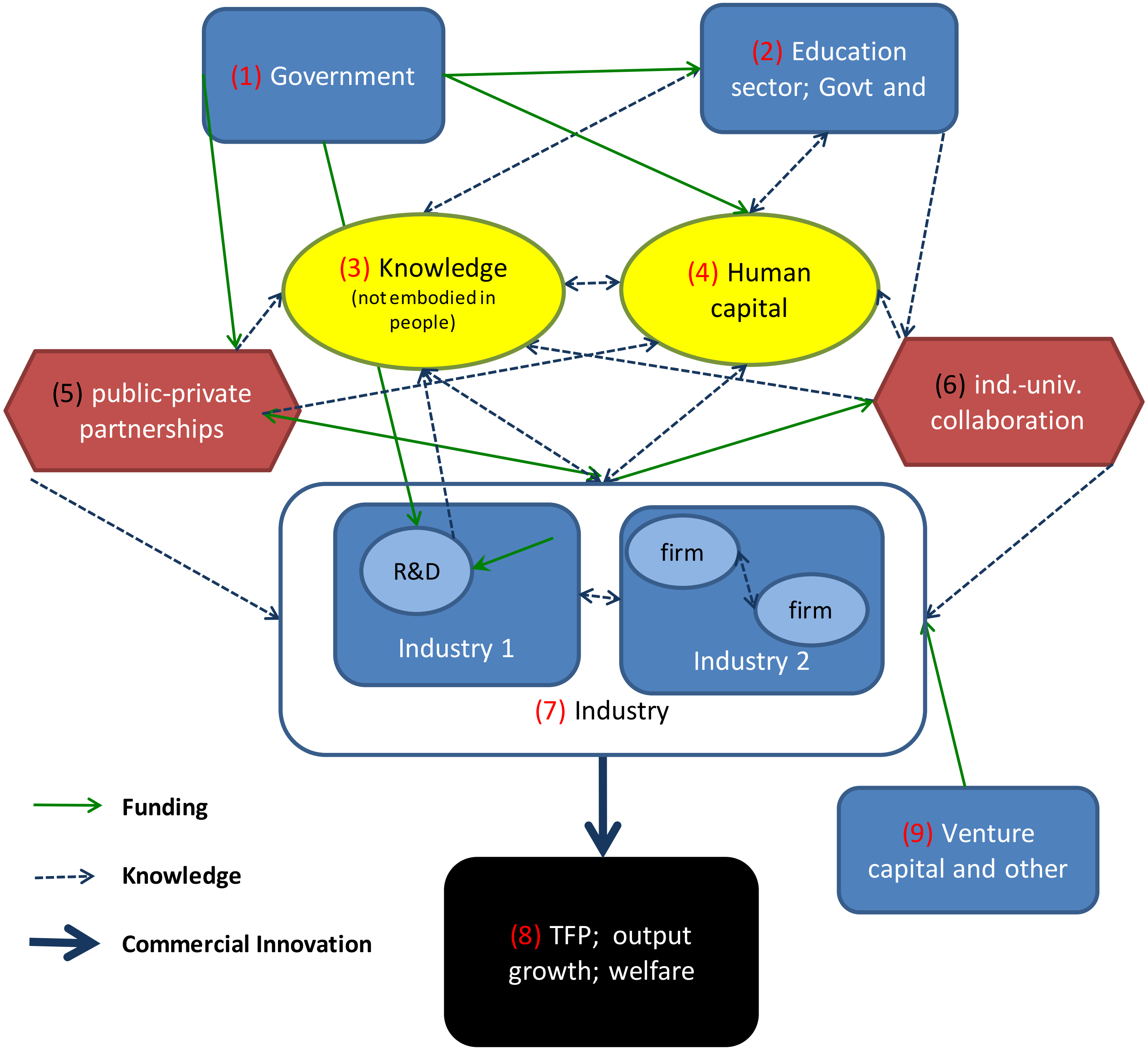
Data collection

- 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



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 *α, β, γ:*

- 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 subjct 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