Science of Science Management

Systems, Modeling, and Policy Topics

October 2-3, 2008

NIH Campus

Bethesda, MD

Thinking Systemically about the Impact of NIH on the Country

NIH Science of Science Management Meeting
October 2-3, 2008

Adam B. Jaffe
Dean of Arts and Sciences
Fred C. Hecht Professor in Economics
Brandeis University

What does NIH do?

- Funds specific research projects
- Funds specific researchers and trainees
- Funds research centers

  - ►Creates incentives that determine behavior of researchers and research institutions

Incentives created by NIH affect:

- Time spent on preparing grant proposals
- Number of technicians, graduate students and postdocs hired in a given lab
- Purchases of instruments and equipment
- Career decisions of specific researchers
- Creation of faculty positions, departments, centers
- Initiation of collaborations between/among research organizations
- Construction of buildings

NIH Determines the Research Infrastructure for the Life Sciences

- Directly (e.g. training grants, equipment purchases)

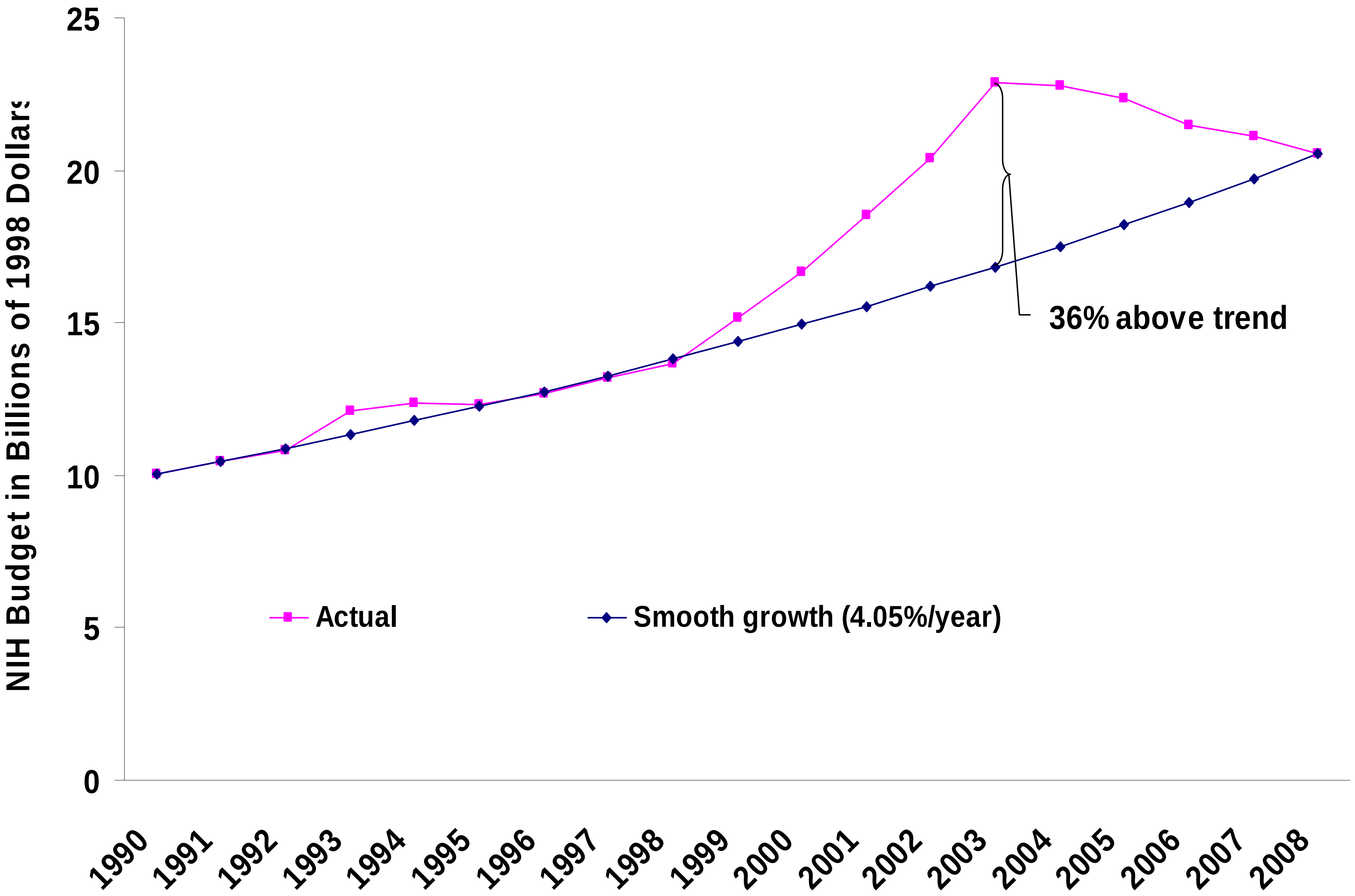
AND

- Indirectly—through influence on researchers and institutional decisions

►Huge part of the overall impact of NIH funding

- For good or ill…

Be Careful What You Wish For



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OPASI

Systems of Innovation
in biomedicine
and health

Susan Cozzens
Technology Policy and Assessment Center (TPAC)
Georgia Institute of Technology

Innovation Systems

- Very common concept in national STI policy
- Stems from evolutionary economics
  - Selection environment set by both market and government
- Learning by
  - Doing
  - Using
  - Interacting

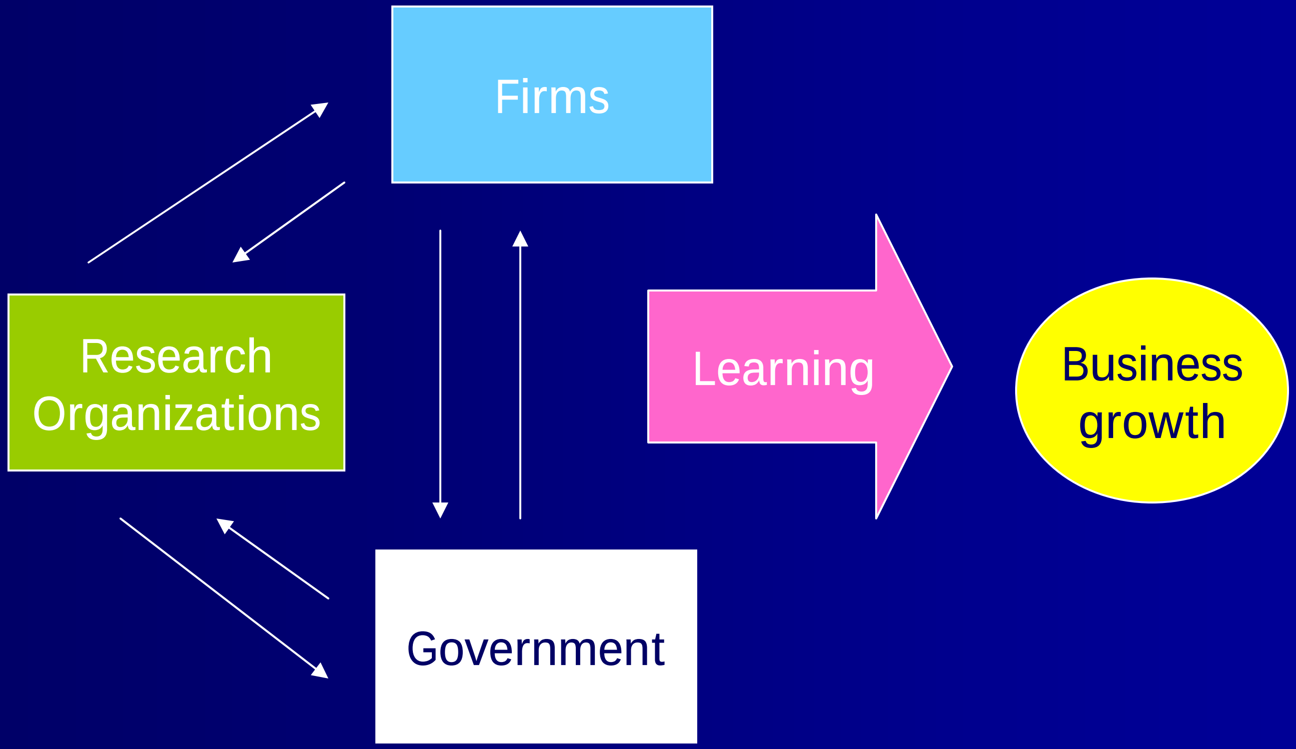
Learning is...

- The process of
  - Generating new approaches (variants)
  - Testing new approaches
  - Adopting the successful ones
- Can also refer to
  - Accumulation of knowledge
  - Competence building

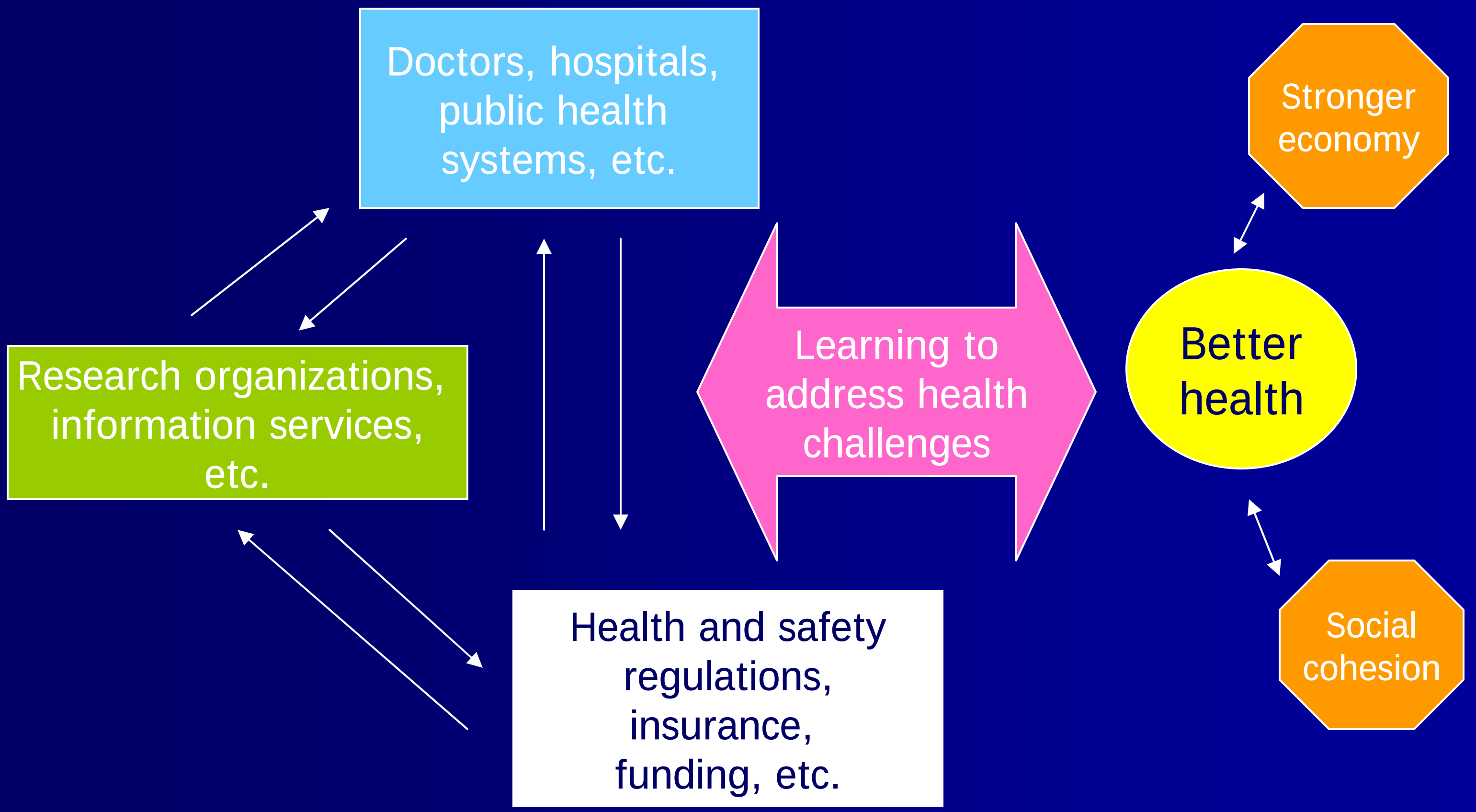
Three main variants

- National Systems of Innovation
  – National agencies, research institutions, science-based industry
- Sectoral Systems of Innovation
  – Generated around a set of products
- Regional Systems of Innovation
  – Place-based, diverse industries

Industrial System of Innovation



Health System of Innovation



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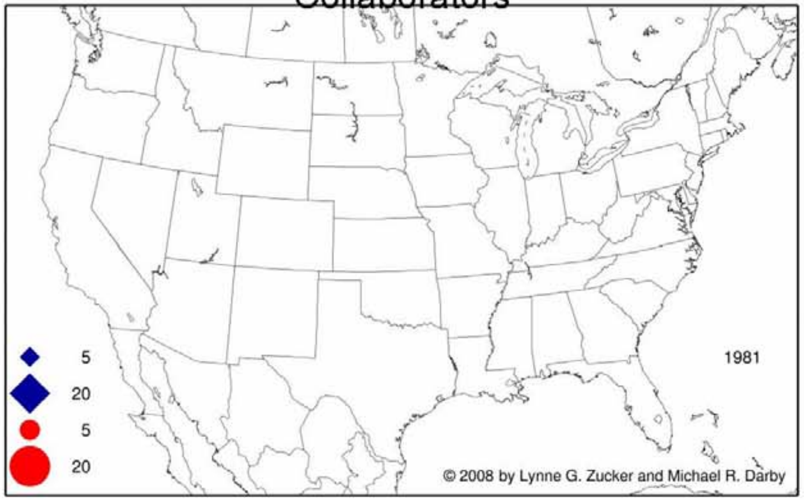
Science & Management of Radical Change

Lynne G. Zucker – UCLA & NBER

- “Technology transfer is the movement of ideas in people.”
  - Donald Kennedy, 1994
- Breakthroughs high on tacit knowledge
  - Natural excludability yields defacto IPRs, discoverers hold knowledge
  - 81% of new authors in GenBank wrote with previous sequence discoverers, 1969-1992
- Measure: processes underlying diffusion of breakthroughs
  - Co-authors = bench science technology transfers
- Maps for visualization: university and firm scientists co-author nano-bio articles
  - Rapid growth
  - Concentrated change: learning by doing and co-location

Firm ( ) & University ( ) Bio-Nano Collaborators



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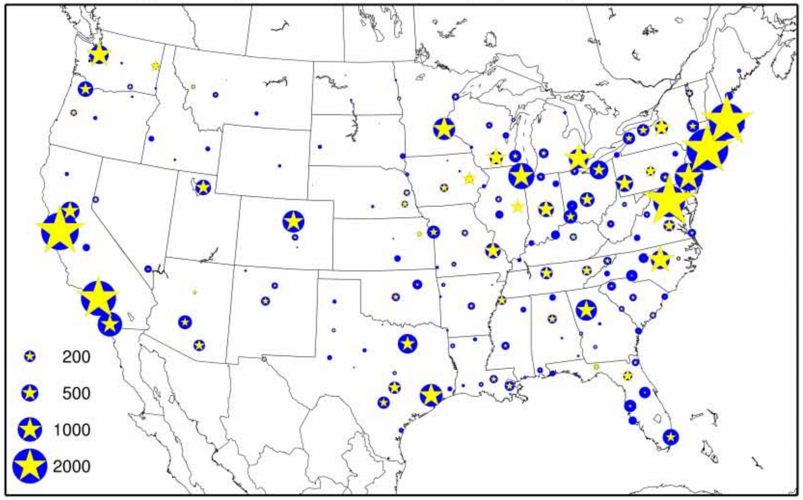
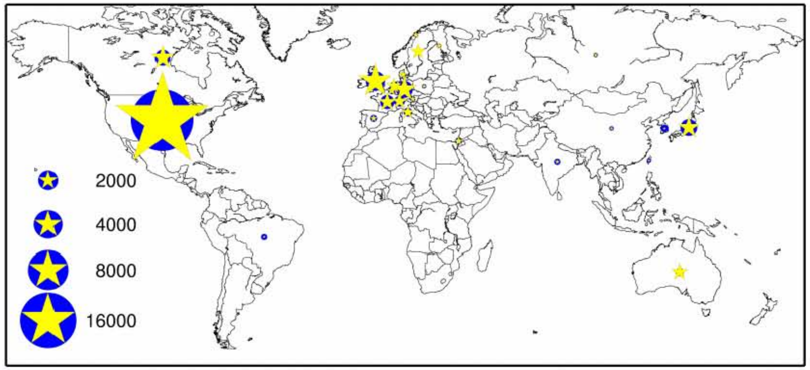
STAR Database
Highly-Cited Scientists & Firm Entry

Example: Cumulative Biology/Chemistry/Medicine Stars (yellow) and Firm Entry (blue), 1981-2004





Stars' Debuts, Residence & Migration, 1981-2004
All S&T Areas (Zucker & Darby 2007)

	U.S.A.	Japan	OECD Europe Top-14 S&T Countries	Top-25 S&T Countries
Unique Stars Ever Resident	3670	266	1960	6599
Professional Debuts	3354	176	1194	5105
Net Inward Migration	-23	13	-39	-51
Stars Resident 12/31/2004	3331	189	1155	5054
Net Inward Migration/Debuts	-0.7%	7.4%	-3.3%	-1.0%

- Highly-cited stars' residence predicts firm entry
- US shows net loss of stars
  - Opposite of biotech results
  - Main beneficiaries are developing countries , esp. in Asia
- Top US scientists report spending 1/3 of their research time writing grant proposals

Metamorphic Progress

Great leaps forward – yards, not inches, creative destruction

- Firms using old technology cannot compete
- Same science & engineering base
  - *Incumbent-enhancing* or competence-enhancing (Tushman & Anderson)
- Disjoint science & engineering base
  - *Entry generating*
  - Normally invented outside of industry of use
- Assessment: Data difficult when create new industries

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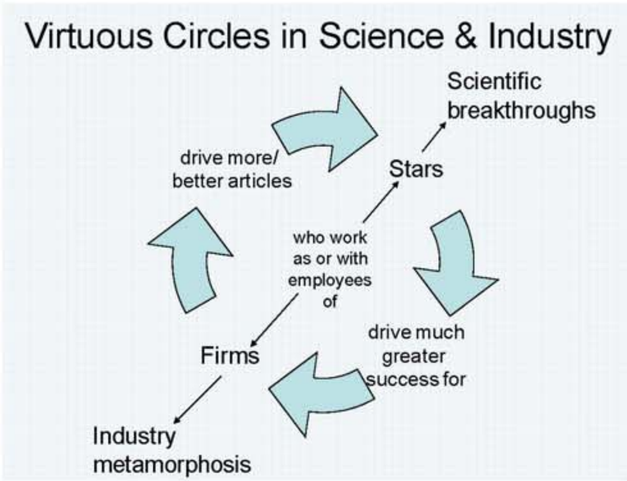
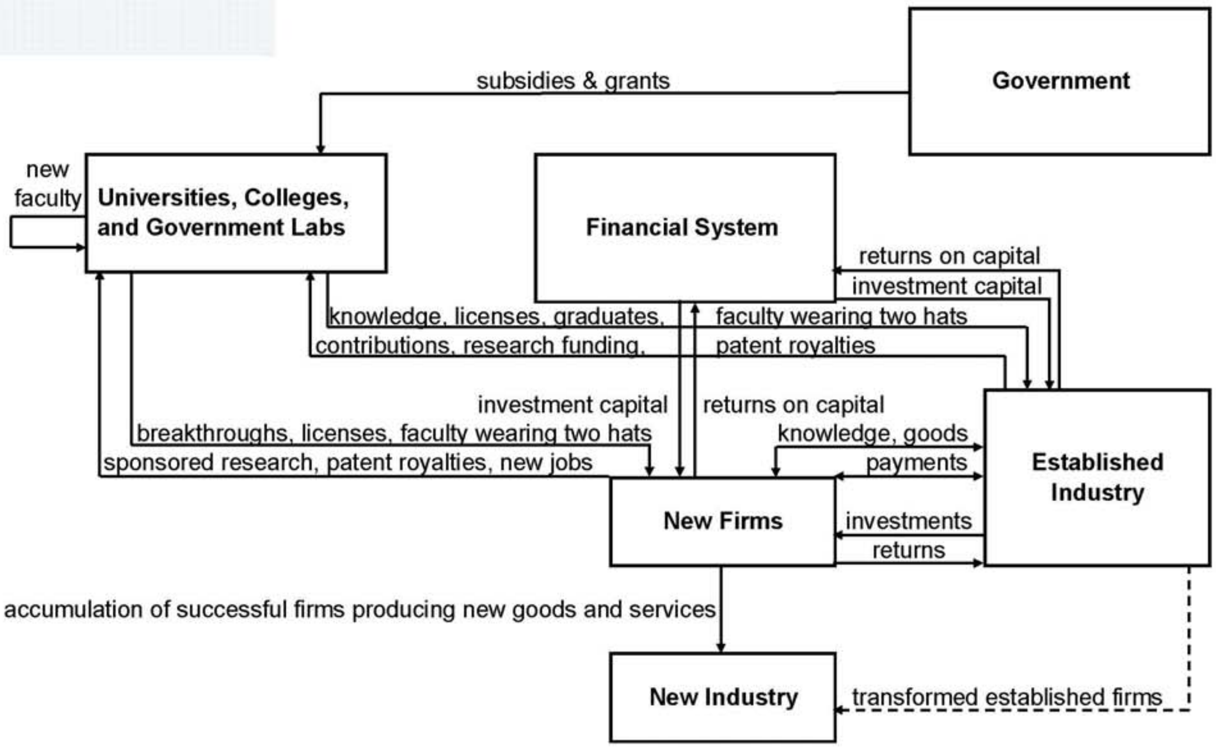


Embedded Virtuous Circles

Flows of Breakthrough Knowledge and Finance



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Policy Issues: NIH Role?

- Virtuous circles? When and where?
- Loss or gain? Scientific productivity of scientists commercializing discoveries
- Reduction/increase in amount of science contributed to the common pool by publishing
- Deflection of development of science toward/away from commercially relevant problems
- Conflict of interest leading to scientists' distorting their findings
- Conflict of commitment to the university

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"... social science of
science policy needs to
grow up, and quickly." J. Marburger, April 2005.

PATHS TO OUTCOME-BASED INNOVATION POLICY: Theory, Method, Tools

NIH Science of Science Management Meeting
Systems/Modeling/Policy Group

Daniel Sarewitz
Arizona State University
Consortium for Science, Policy, and Outcomes

Consortium for Science, Policy & Outcomes

Theory: Know-How and Progress—3 Rules for Technological Fixes

I. R&D is most likely to contribute decisively to solving a social problem when it focuses on improving a standardized technical core that already exists.

II. The technology must largely embody the cause-effect relations connecting problem to solution.

III. The effects of the technology must be amenable to measurement and assessment using relatively unambiguous or uncontroversial criteria.

Collaboration with R. Nelson
Innovations, 2008;
Nature, forthcoming

Theory of Know-How and Progress

DO THE RULES APPLY?

Yes: appropriate R&D investments have the potential to stimulate rapid progress toward the desired goal.

No: R&D programs should not be expected to succeed, or advertised as having any real promise of succeeding, at least in the short and medium run. Success is only possible over the long-term, and the probability of failure will be high.

Method: Public Value Mapping

Traditional Science Policy Logic Model

Research Activities, Institutions, and Translation

Policy Analysis using
Standard Market-based Assessment
or Output Assessment Approach

**Potential Public Value Failure
Due to Value Gap**

Societal Impact

Enhanced Science Policy Logic Model
Adds PVM to Avoid Public Values Failure

Assertions of Public Value Priorities and
Societal Benefits, Risk, and Impacts

Public Value Mapping
(Non-Economic Analysis)

Case Study Approach

- Summarize case background and identify stakeholders and knowledge value collective (KVC)
- Secure stakeholder and KVC documents including policy statements, plans, memos, web pages
- Public value statement scan
- Design public value chain (hypothetical relationship between values)
- Value chain analysis (links and hierarchies)
- Assessment of institutional and KVC capacities
- Identify potential values failures (individual value failures and chain failures)

**Retrospective or Prospective Analysis of
Capacities to Achieve Stipulated Public Values**

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PVM Case Studies

Prospective:
- Nanotechnology and Cancer Treatments
- Nanotechnology and Water Treatment

Retrospective:
- Hurricane Katrina
- University-Industry Tech Transfer

Real-Time:
- Climate Change Research
- Natural Hazards Research
- Green Chemistry

Collaboration w/ B. Bozeman, U GA
Supported by NSF SciSIP pgm, Rasmussen Fnd

Tool: Multiple Stressor Analysis

Stressors: Phoenix Water Supply		Est. annual water loss by 2025 (af)
Inefficiency	Municipal	328,000
	Indoor water use	89,000
	Outdoor water use	239,000
	Agriculture	127,000
Biophysical stress	Biophysical	242,000
	Additional demand due to UHI	25,000
	Reduction of surface water flow in the lower Colorado basin due to the effects of climate change	216,000

Source: N. Chhetri, ASU, in prep.

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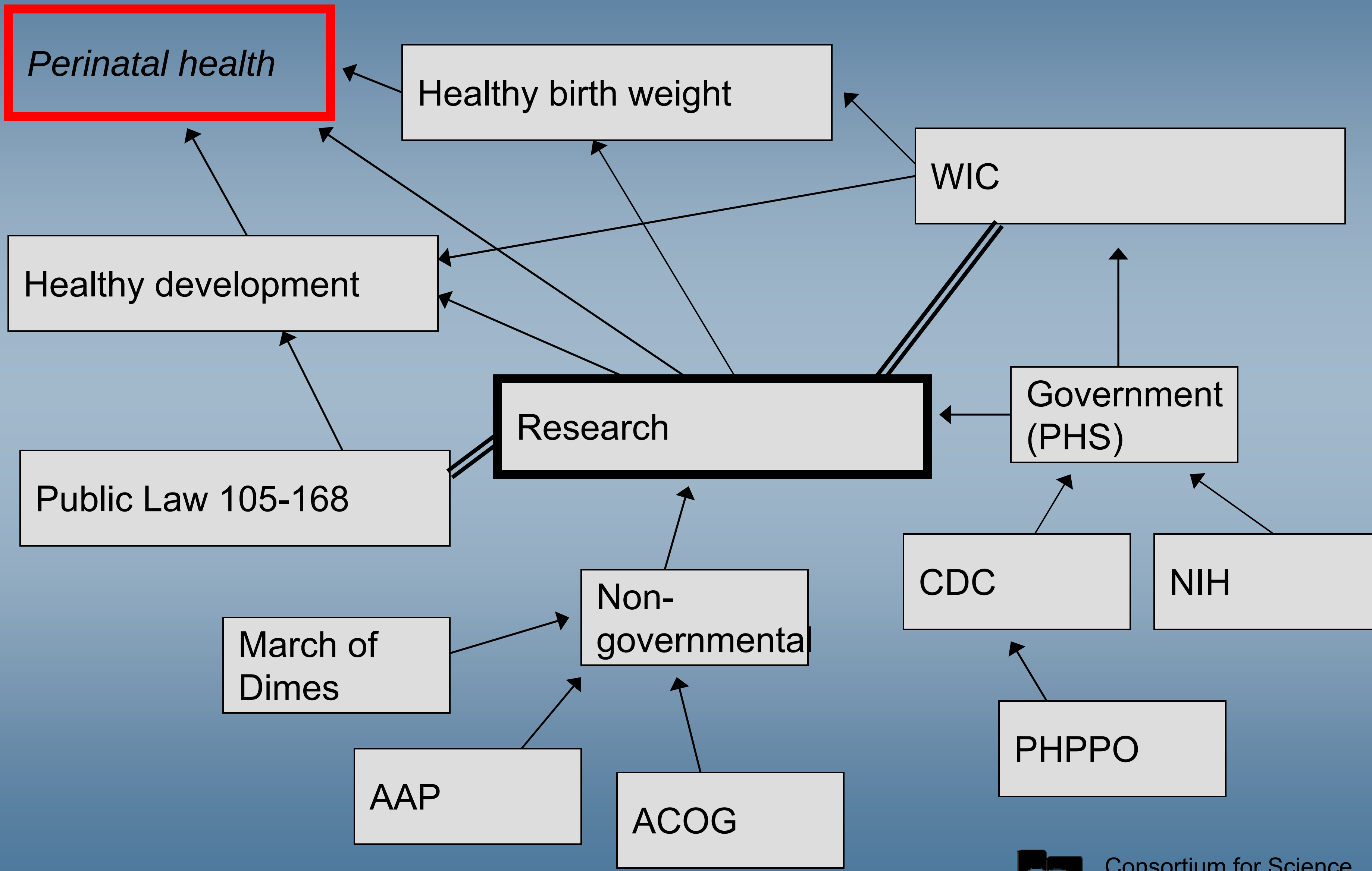
Tool: Multiple Solution Paths



Source: Garfinkel et al, 2006, AJPH

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