Mapping the U.S. Innovation System Today

Fred Block
UC Davis
January 8, 2016

LBNL Seminar

Outline

1. How the innovation system has been transformed.

2. Strengths and weaknesses.

3. Dilemmas for managing a complex and decentralized innovation system.

Part 1: A Transformation over 30 Years

■ The dramatic decline of the big corporate laboratories.

■ The movement of industry scientists to small firms.

■ Innovation now occurs overwhelmingly in public-private collaborations.

Ph.D. scientists at small firms

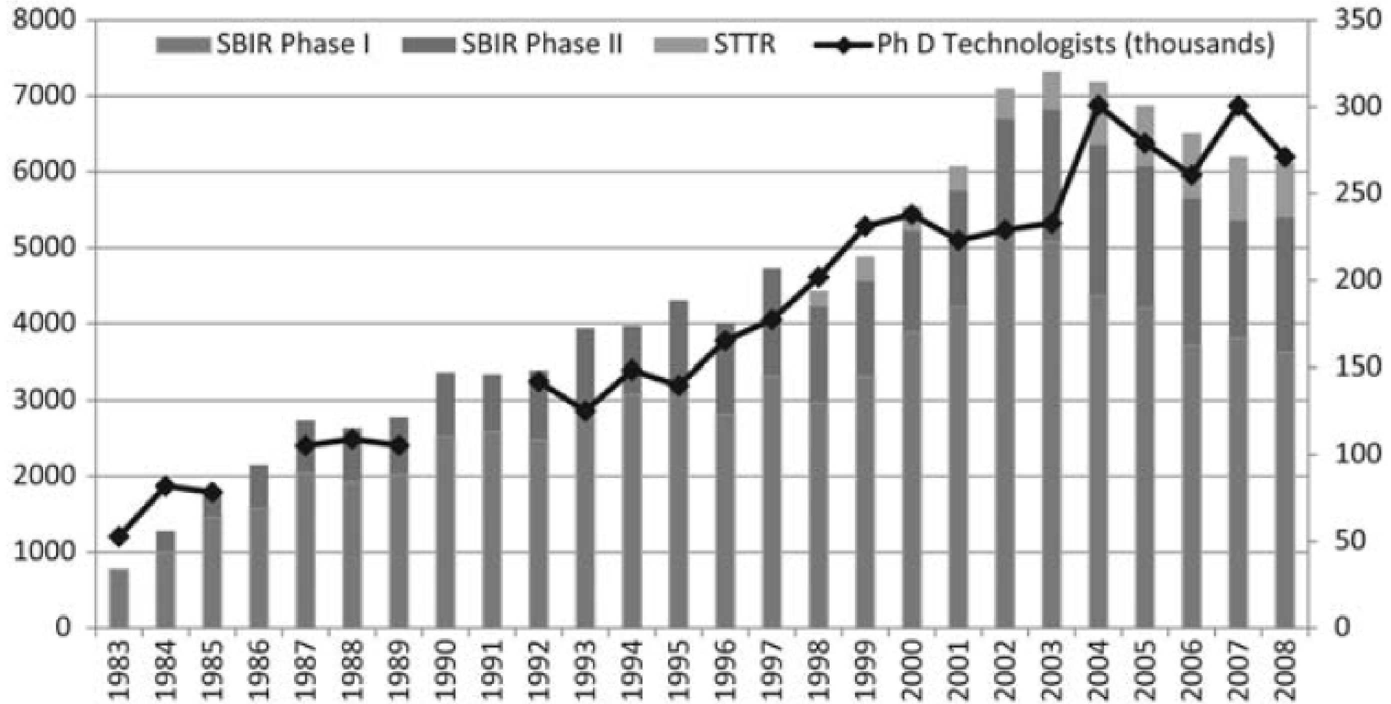


Figure 2 Trends in SBIR awards and PhD technologists employed by firms with fewer than 500 employees. *Note*: Data for 1983–1984 are for firms with fewer than 1000 employees; see note 7.

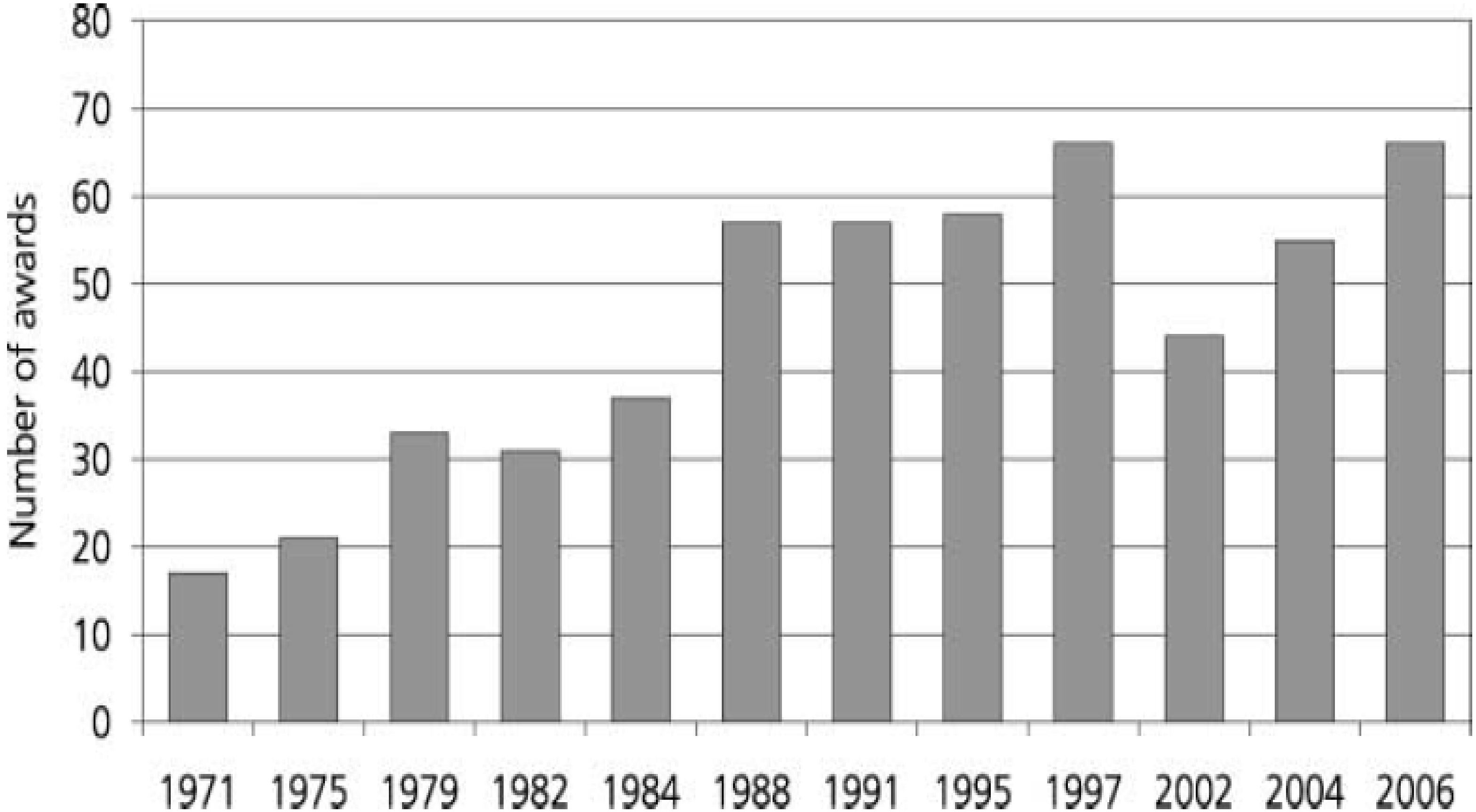


Figure 1 R&D 100 awards to inter-organizational collaborations.

Transformation began in the 1980's

- New era started from the example of computers and biotech—central role of new firms.
- Has now diffused to virtually every sector of the economy.
- The new model is government-university-industry cooperation.

Government-University-Industry = GUI

Pronounced as Gooey and difficult to manage.

Key elements I

- Tens of thousands of daily collaborations between industry technologists and publicly funded scientists

- Occurring in federal laboratories and on university campuses

Key elements II

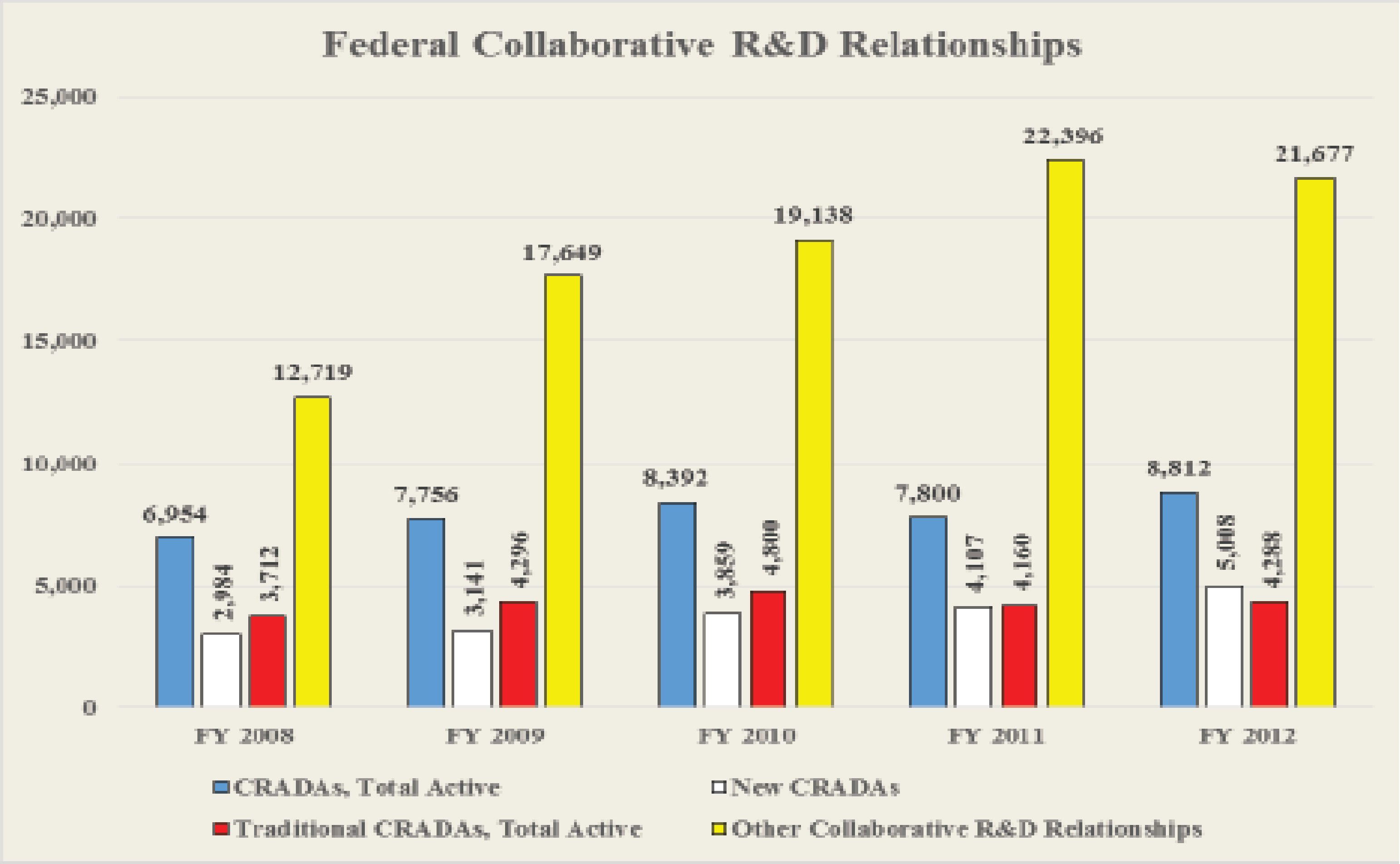
- Innovations are often driven forward by new firms (startups) created by scientists and engineers
- New firms are often funded through SBIR—Small Business Innovation Research Program.

Why the change ?

- Greater technological and scientific complexity
- Even the most successful firms cannot do it on their own
- Creativity and innovation flourish when technologists are not in hierarchical organizations

Many different programs:

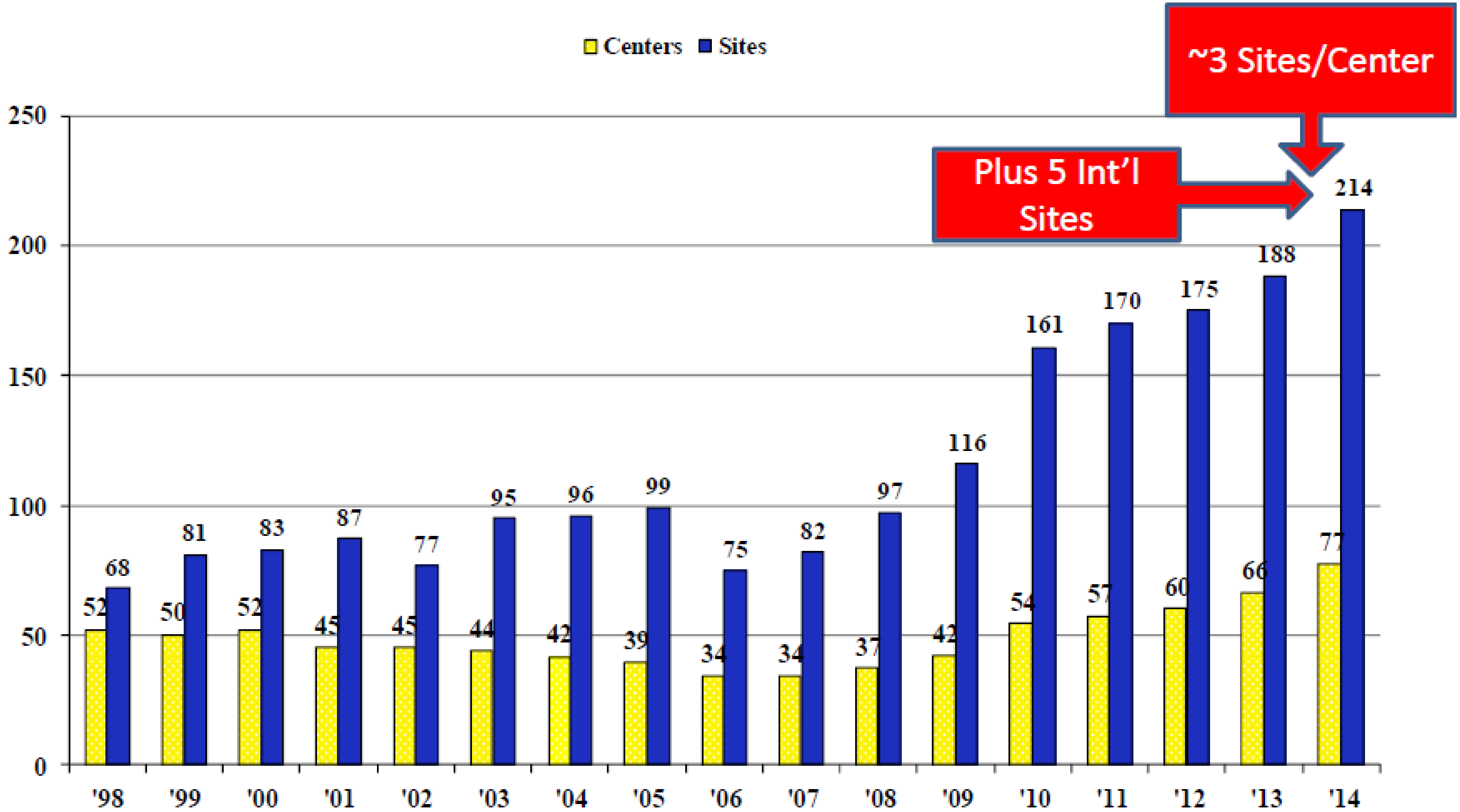
- Cooperative research and development agreements, work for others, facilities agreements at federal labs
- Cooperative Research Centers on campuses—such as ERC's, IUCRC's



	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
CRADAs, Total Active	6,954	7,756	8,392	7,800	8,812
New CRADAs	2,984	3,141	3,859	4,107	5,008
Traditional CRADAs, Total Active	3,712	4,296	4,800	4,160	4,288
Other Collaborative R&D Relationships	12,719	17,649	19,138	22,396	21,677

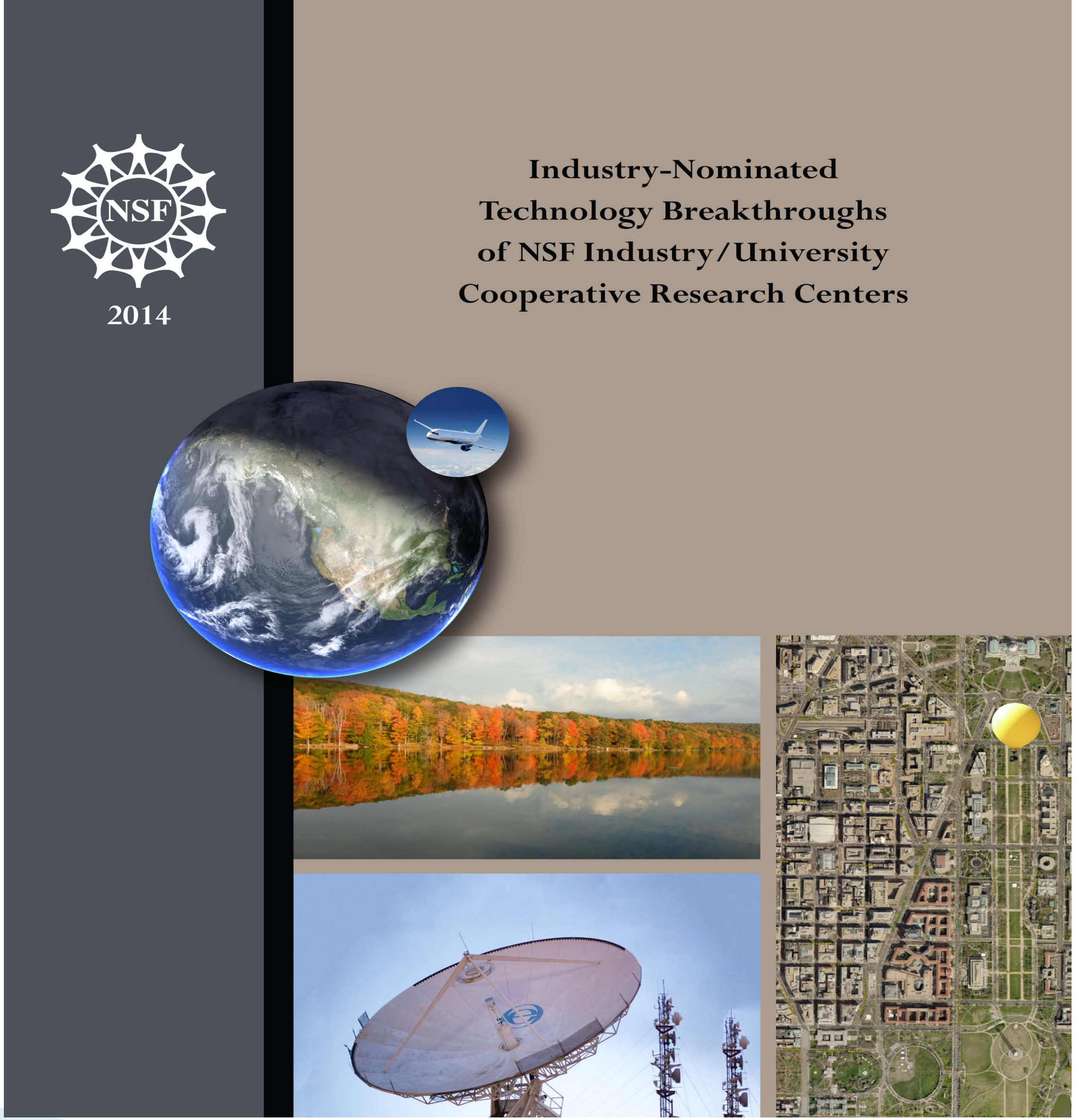
ACTIVE CENTERS AND SITES BY YEAR*

Industry/University Cooperative Research Centers



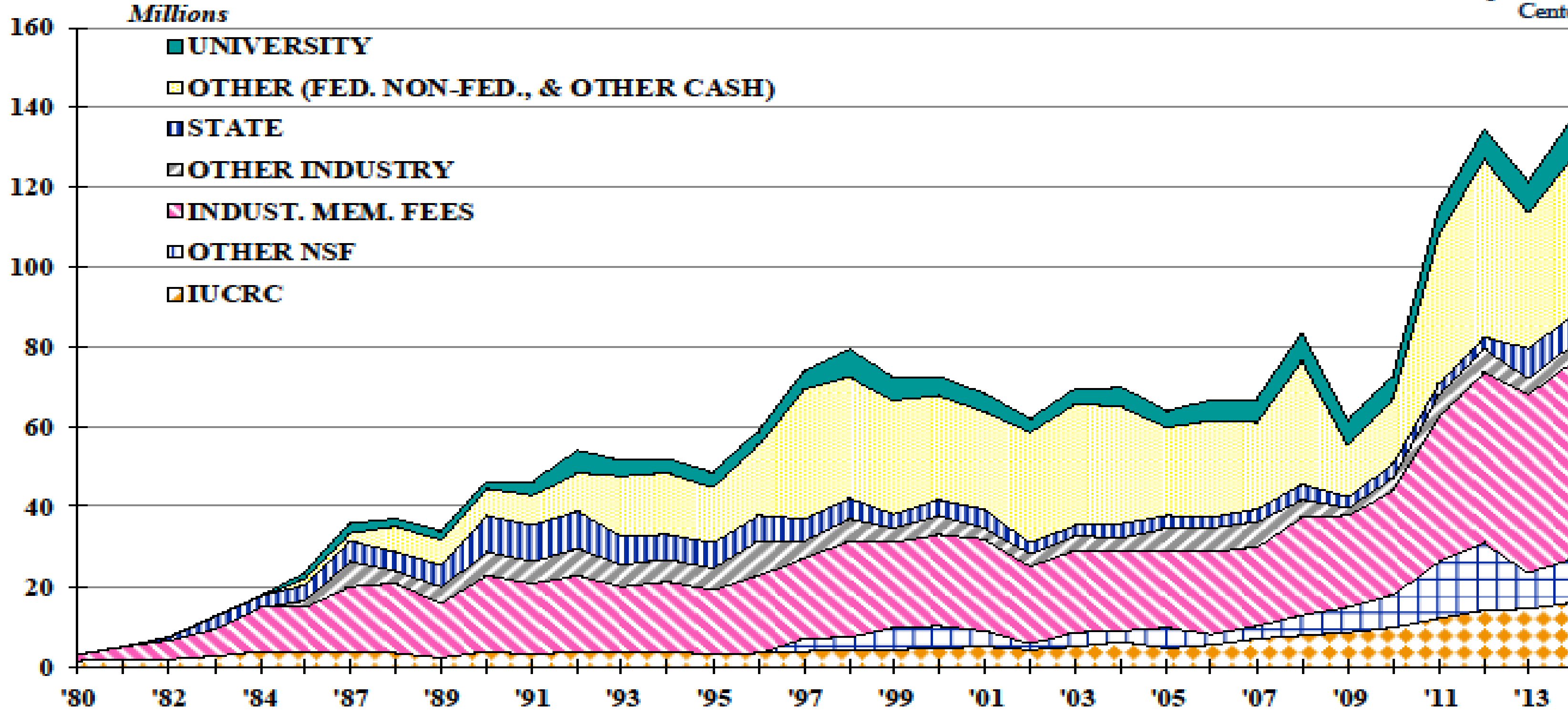
*Data Current for NSF FY2014

NSF-I/UCRC Center Structure Database


NSF
2014
Industry-Nominated
Technology Breakthroughs
of NSF Industry/University
Cooperative Research Centers

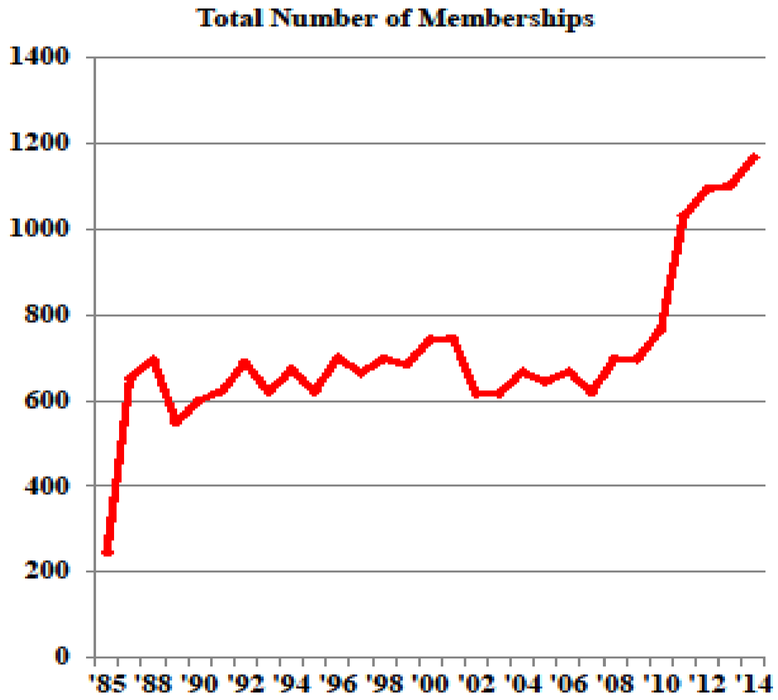
Total Funding by Source in Dollars

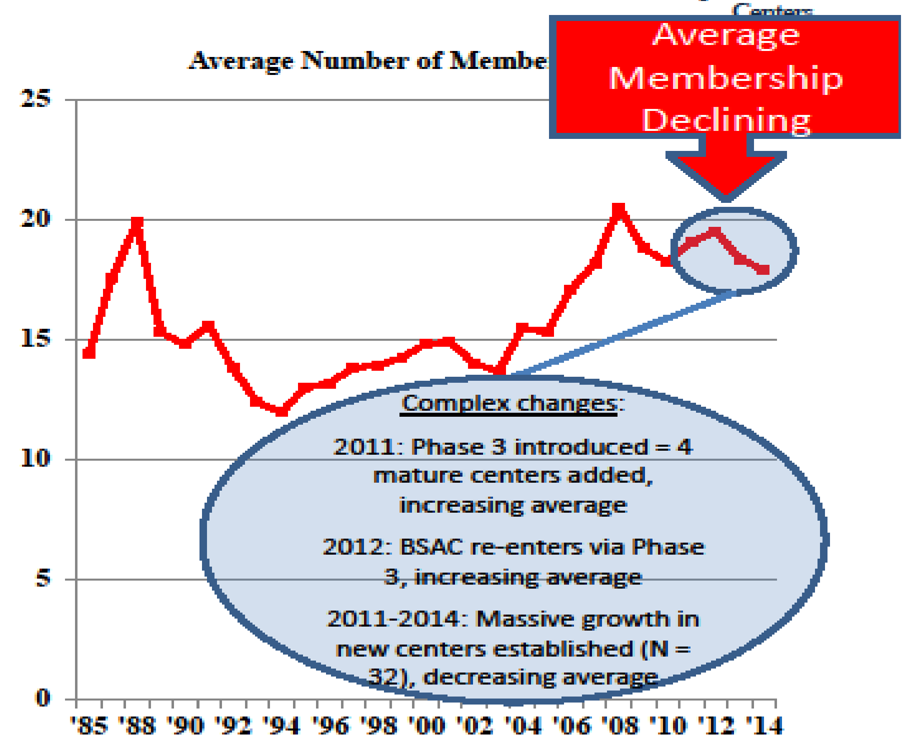
Industry/University Cooperative Research Centers



FY 2013-2014 NSF-I/UCRC Center Structure Database

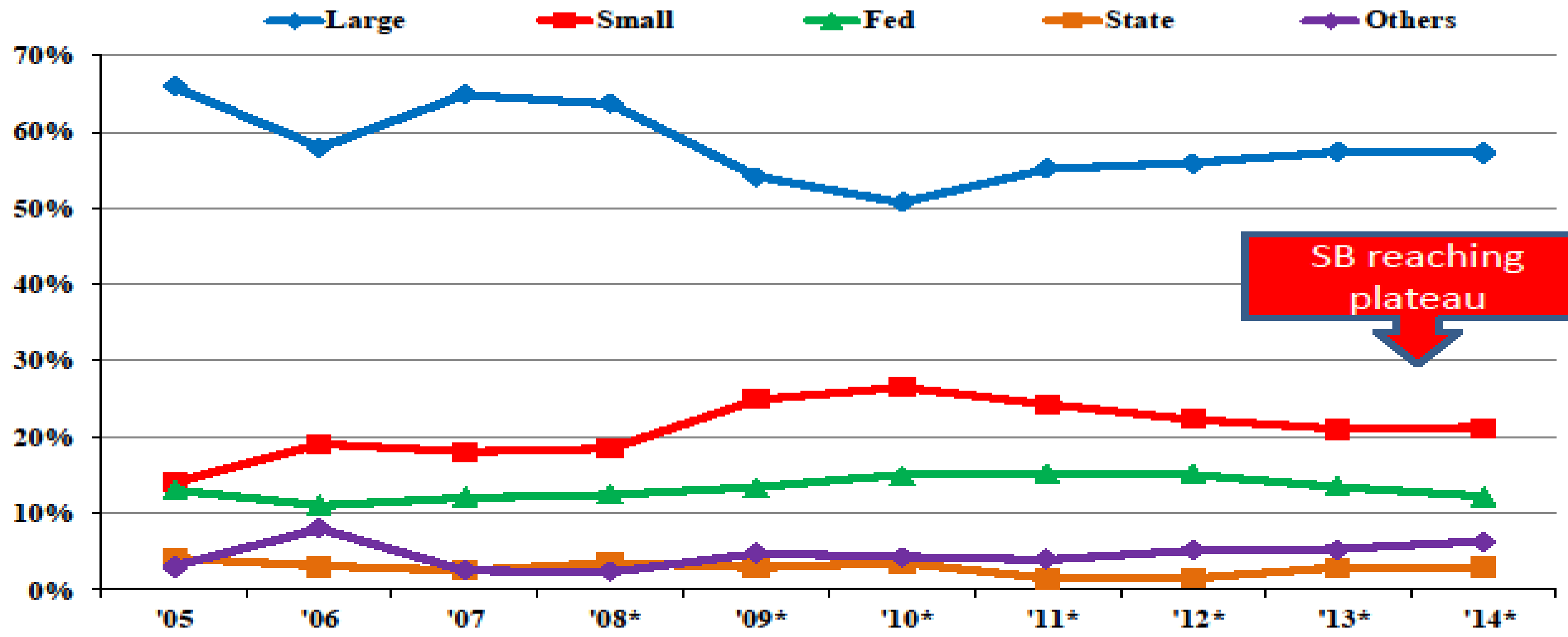
Industrial Memberships





FY 2013-2014 NSF-I/UCRC Center Structure Database

Member Composition 2005-2014



*Years Advanced Forestry excluded as a small business outlier: '08 Small = 36, '09 Small = 49, '10 Small = 57, '11 Small = 66, '12 = 71, '13 = 77, '14 = 86.
^ Categories comprising Others include: non-profit, non-US gov't, and other org.

FY 2013-2014 NSF-I/UCRC Center Structure Database

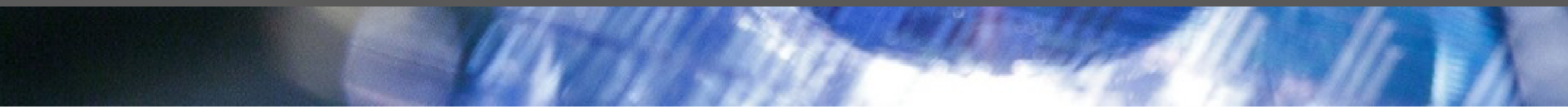
The Model has spread.

- Department of Energy:
  - Bioenergy Research Centers (3)
  - Frontier Energy Research Centers (46)
  - Energy Innovation Hubs (4)
- Interagency Effort—Advanced Manufacturing Institutes—16 by the end of 2016.
- Cluster strategy pursued by Economic Development Administration.

FHE MII Information Sheet

Flexible Hybrid Electronics Manufacturing Innovation Institute

September 2015



Mission

The FHE MII will pioneer a new era of advanced Flexible Hybrid Electronics manufacturing in the U.S. by:

- Catalyzing a U.S. FHE ecosystem
- Providing new manufacturing capability to the Department of Defense and industry partners
- Developing multiple product demonstrators
- Educating and training professionals and technicians
- Exploiting the Silicon Valley's innovation culture

The FHE MII is the 7th of 9 manufacturing innovation institutes to be established as part of the National Network for Manufacturing Innovation (NNMI) an effort to create a competitive, effective, and sustainable manufacturing research-to-manufacturing infrastructure. The goal is to enable U.S. industry and academia to solve manufacturing challenges for advanced technologies.

Part II: Strengths and weaknesses

- Strengths—

  1. Broadening the innovation funnel (think smart phone apps)—ubiquitous innovation.

  2. Reduced barriers to entry for innovators (think Tesla).

Part II: Strengths and weaknesses

- Weaknesses—

  1. Massive coordination problems because innovation is no longer being carried by deep pocketed corporations.

  2. Innovators usually have to build complex political alliances to scale up new technologies.

The problem of network failure

- Innovators have trouble finding partners/allies who are:
  1. trustworthy
  2. competent
  3. have the clout to overcome barriers such as regulations or missing infrastructure.

Conceptualizing the role of public entrepreneurs

- They mitigate network failure by:
  1. Helping innovators find partners.
  2. Upgrading and validating the competence of network actors.
  3. Discouraging bad behavior such as theft of IP.
  4. Develop policies to overcome regulatory and infrastructure barriers.

Need a mixture of decentralized and centralized efforts

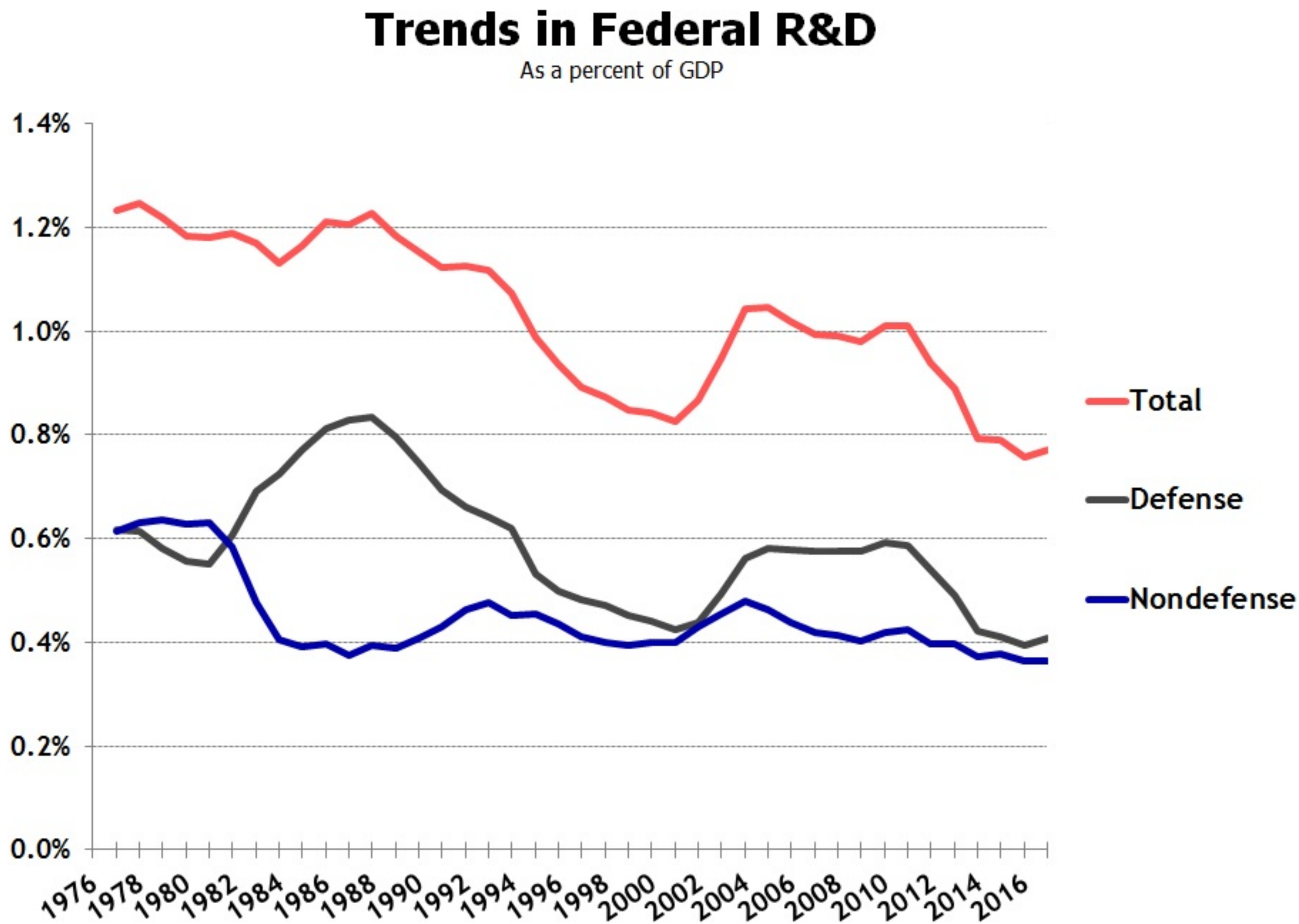
- Connecting network actors requires decentralized expertise—hence all these collaborative research centers and bridging organizations.
- Overcoming barriers often requires federal resources.

Part III: Dilemmas of Managing this System

- Lack of public knowledge, understanding, visibility, legitimacy
- GUI coordination
- Funding
- A dysfunctional intellectual property regime
- Need for new financing arrangements for startups

GUI = high level of interdependence

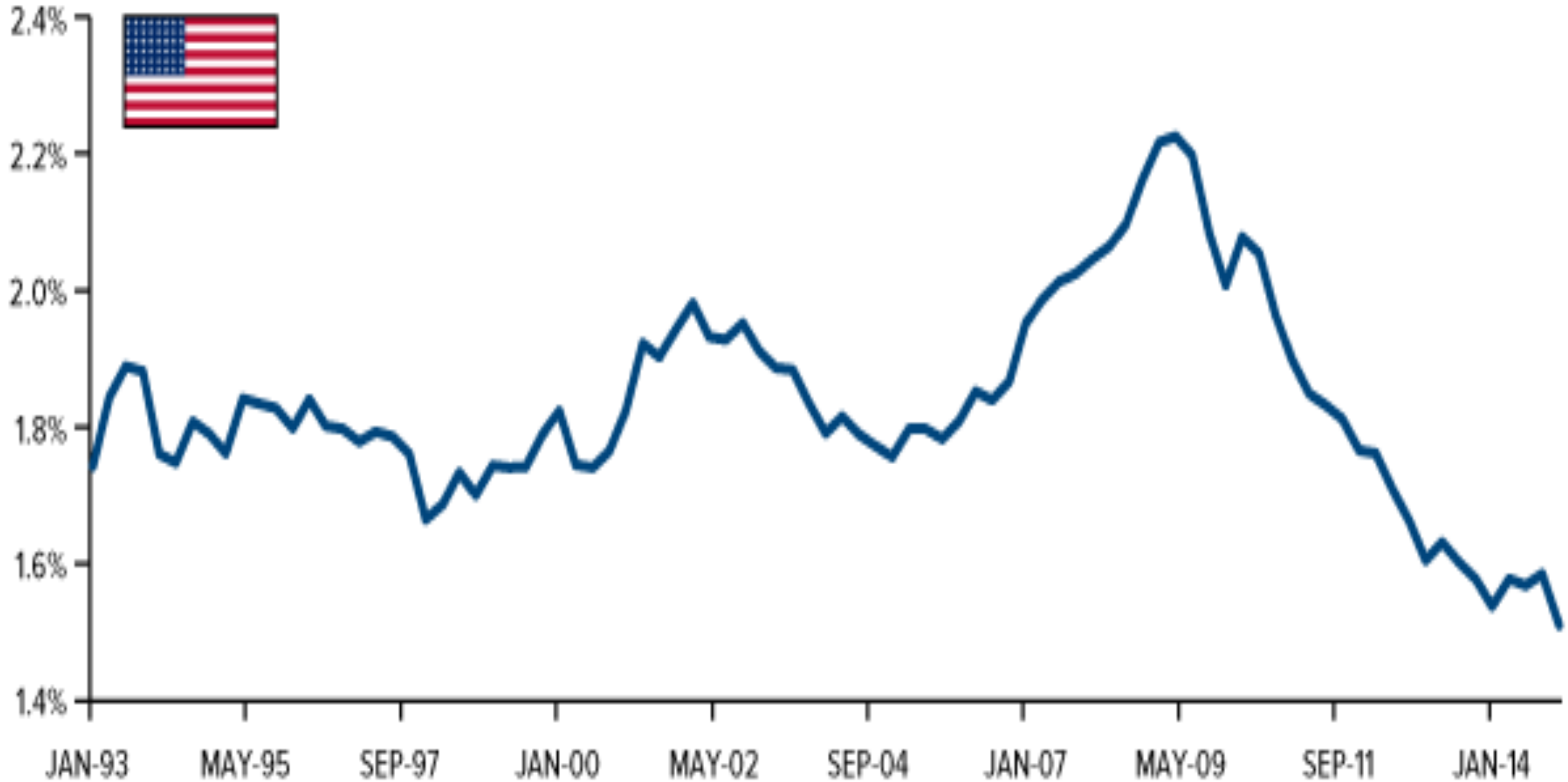
- But we do not have a road map of how to organize these collaborations
- Worse—we are blinded by outdated ideas such as “the ivory tower university” or the faith that the free market will solve all problems



Source: Up to 1994 - National Science Foundation, Survey of Federal Funds for Research and Development; 1995 to Present - AAAS data. GDP figures are from *Budget of the U.S. Government FY 2016*. FY 2015 and FY 2016 figures are estimates.

Total Public Construction Spending in the U.S. as a Percentage of GDP

January 1, 1993 – January 1, 2015



Source: Federal Reserve Bank of St. Louis, U.S. Global Investors

Intellectual property

- We have gone too far in treating knowledge as a commodity and subdividing it into tiny pieces
- The current system makes collaboration much more difficult than it should be

Startups continue to face the valley of death

- The venture capital system is broken; it only works for unicorns
- We need new mechanisms so that tens of thousands of small tech startups have a plausible chance to survive

Conclusion

- Importance of understanding how dramatically the innovation environment has shifted over a generation.

- Need to forge new rules, new institutions, new practices to make this new system work.