Changing Research Landscape: Implications for Publishing

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Georgia State University and NBER

SSP May 31, 2017

Focus

- Market for PhDs
- Trends in employment
  - Both in universities and in firms
- Implications for publishing
- Conclude by making comments on risk aversion among scientists and funding organizations

PhD Production In US: 2015

- 12,519 PhDs in life sciences
- 5,923 in the physical and earth sciences
- 9,897 in engineering
- 3,823 in math and computer sciences
- 9,094 in psychology and the social sciences

2015 SED Table 6

Many New PhDs Lack Definite Commitments at Time They Finish

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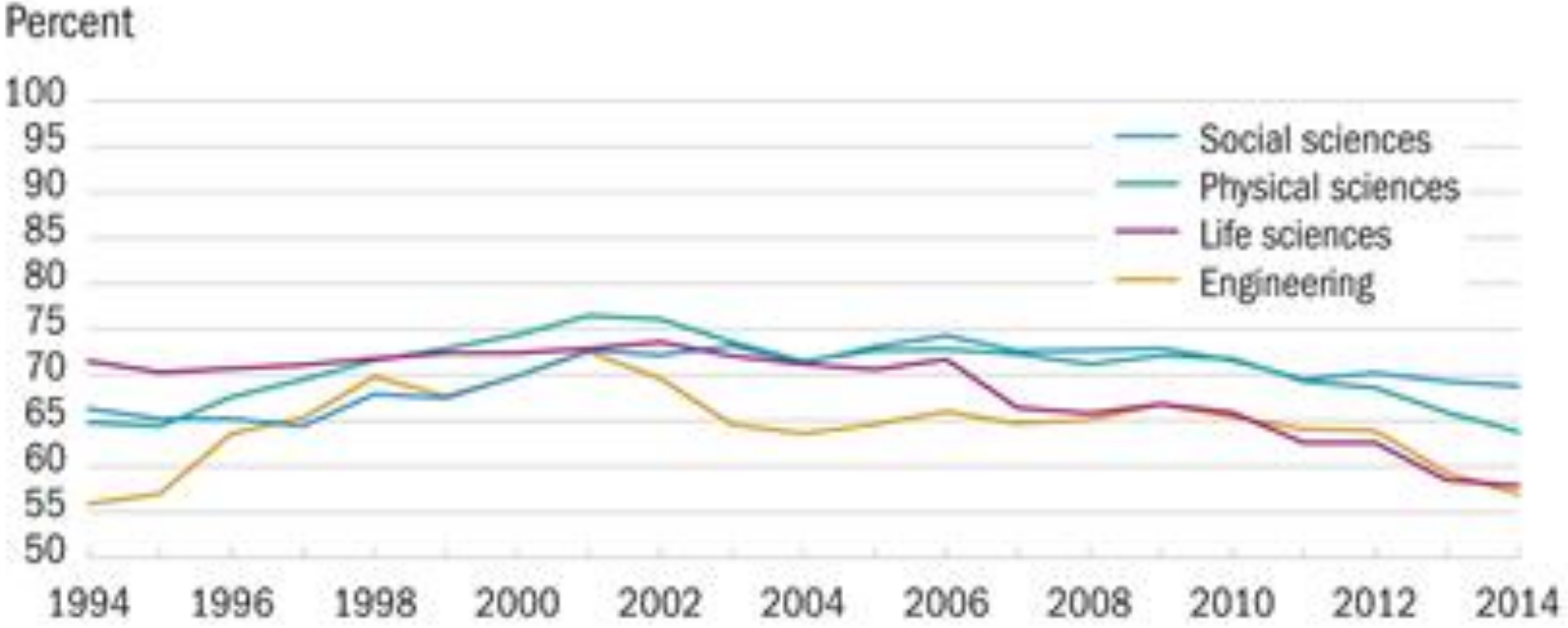
Definite commitments at doctorate award, by science and engineering fields of study: 1994–2014



NOTE: Definite commitment refers to a doctorate recipient who is either returning to predoctoral employment or has signed a contract (or otherwise made a definite commitment) for employment or a postdoc position in the coming year.

Related detailed data: tables 42, 43.

Many with Definite Commitments Will go to Postdoctoral Training

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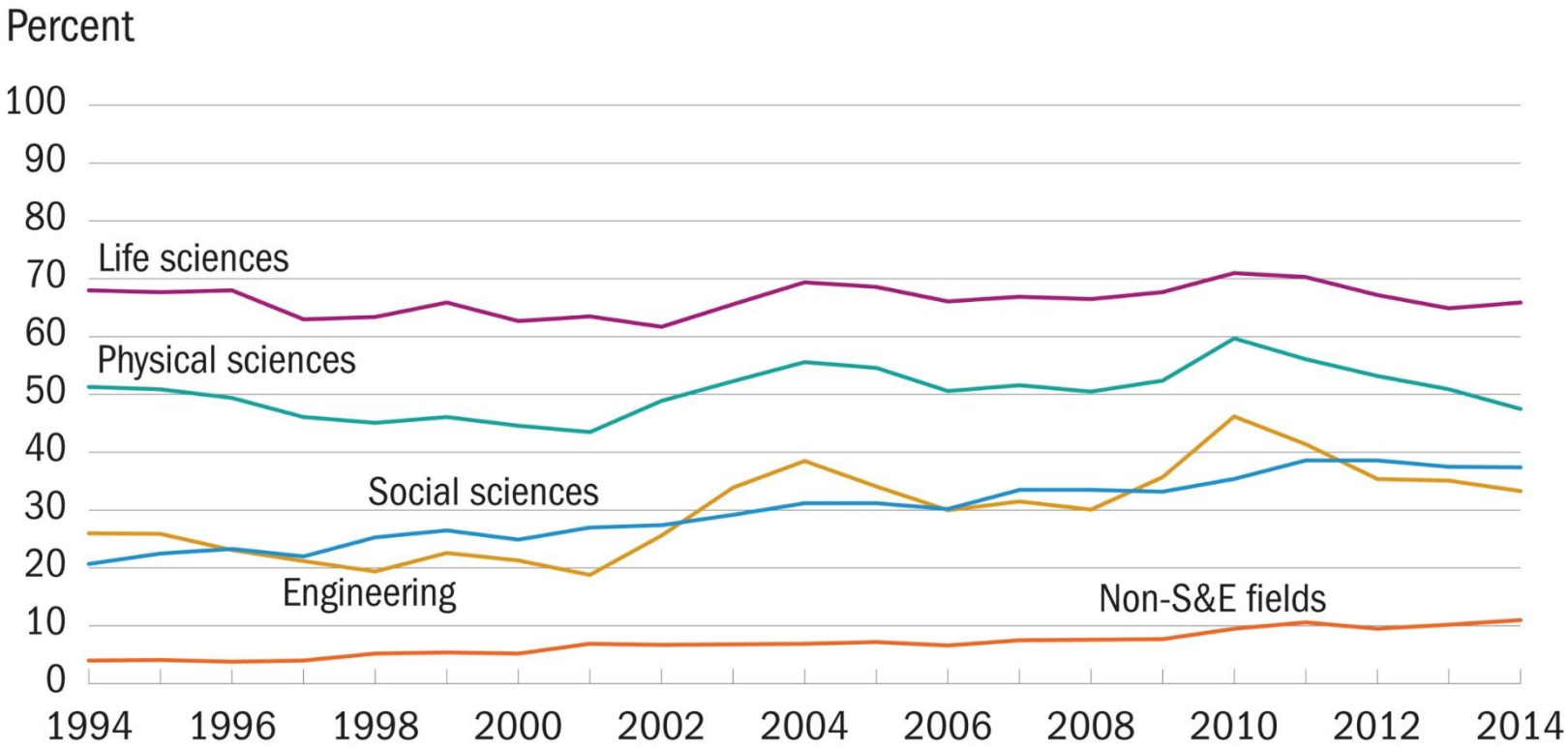
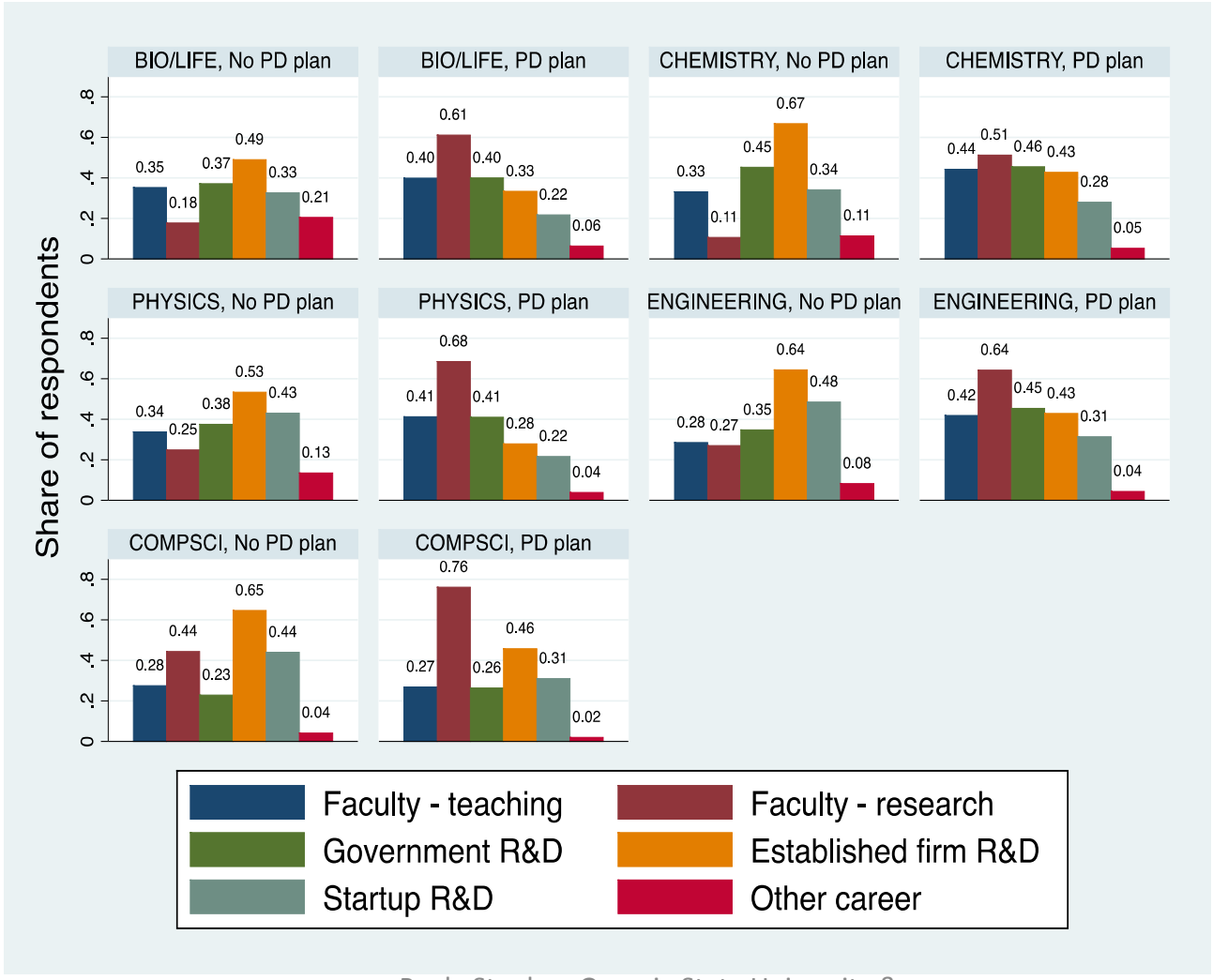
U.S. postdoc rate, by field of study: 1994–2014



NOTE: Percentages are based on the number of doctorate recipients who reported definite postgraduation commitments for a postdoc or other employment and plans to stay in the United States.
Related detailed data: tables 44, 51, 52.

Majority of Postdoctoral fellows have preference for research faculty position

Majority of Postdocs Have Preference for Job in Academe



Sauermann & Roach: "Why Pursue a Postdoc?"

Positions are Scare: Academe is the "alternative" career track now

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Tenure and Tenure-track Positions 3-5 Years Since PhD

- 10.6% biological, agricultural and environmental sciences; (17.3%)
- 14.3% physical sciences; (18.8%)
- 14.6% engineering; (22.7%)
- 13.8% computer and information sciences; (55.7%)
- 29.6% math and statistics; (54.9%)

Red is 2013; Blue is 1993; Table 3-16 Indicators.

Competition is strong for tenure-track positions at research institutions

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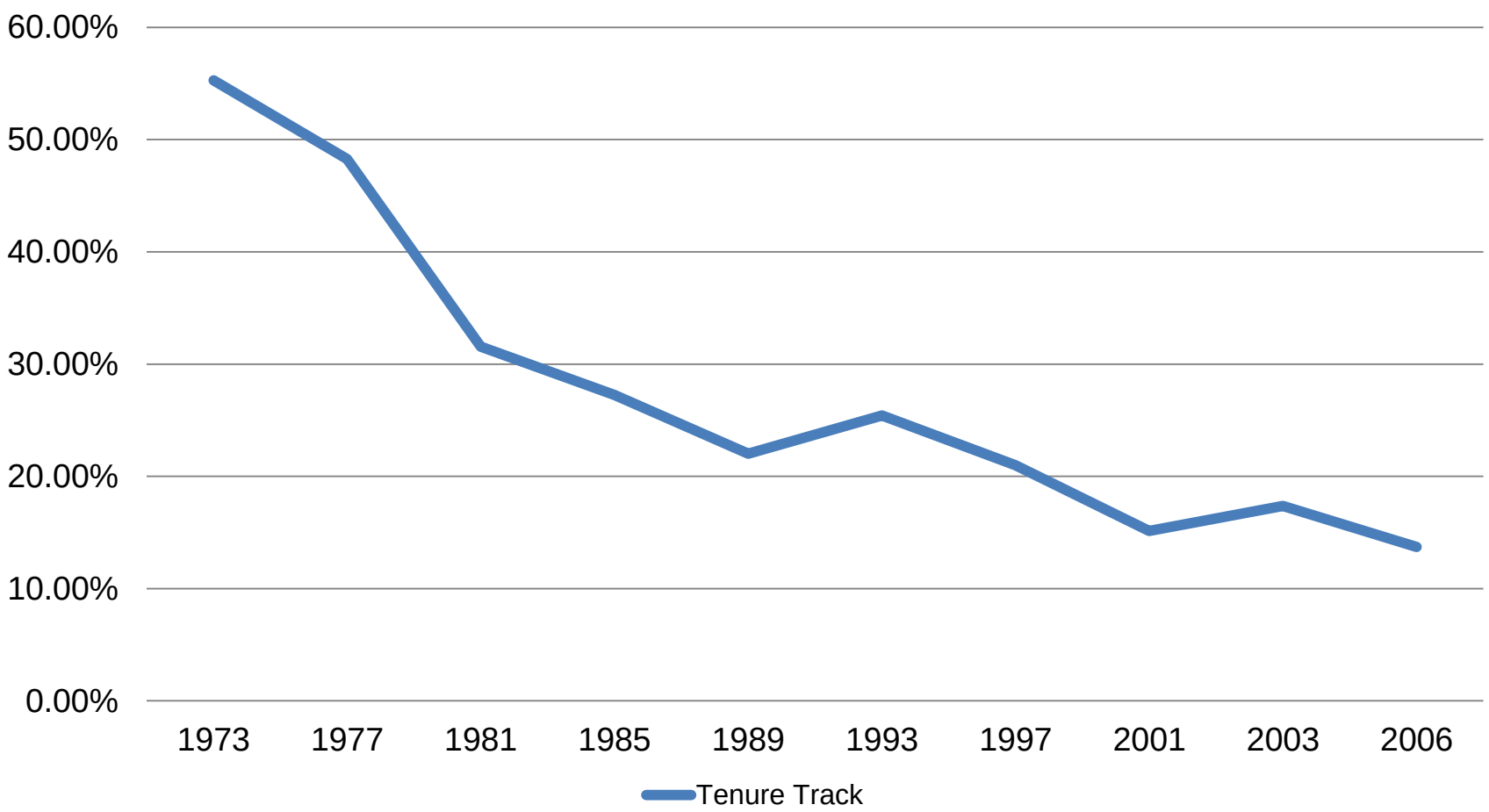
Supply of Postdocs Greatly Exceeds Demand for Tenure-track Positions

- NSF survey reports 48,011 postdocs in 2015 in non-clinical fields
- Biological sciences: 19,304
- Physical sciences: 7,358
- Engineering: 7,656

GSS Survey:
https://ncsesdata.nsf.gov/gradpostdoc/2015/html/GSS2015_DST_32.html

Not always like this

Biological Sciences: 5-6 Year Cohort

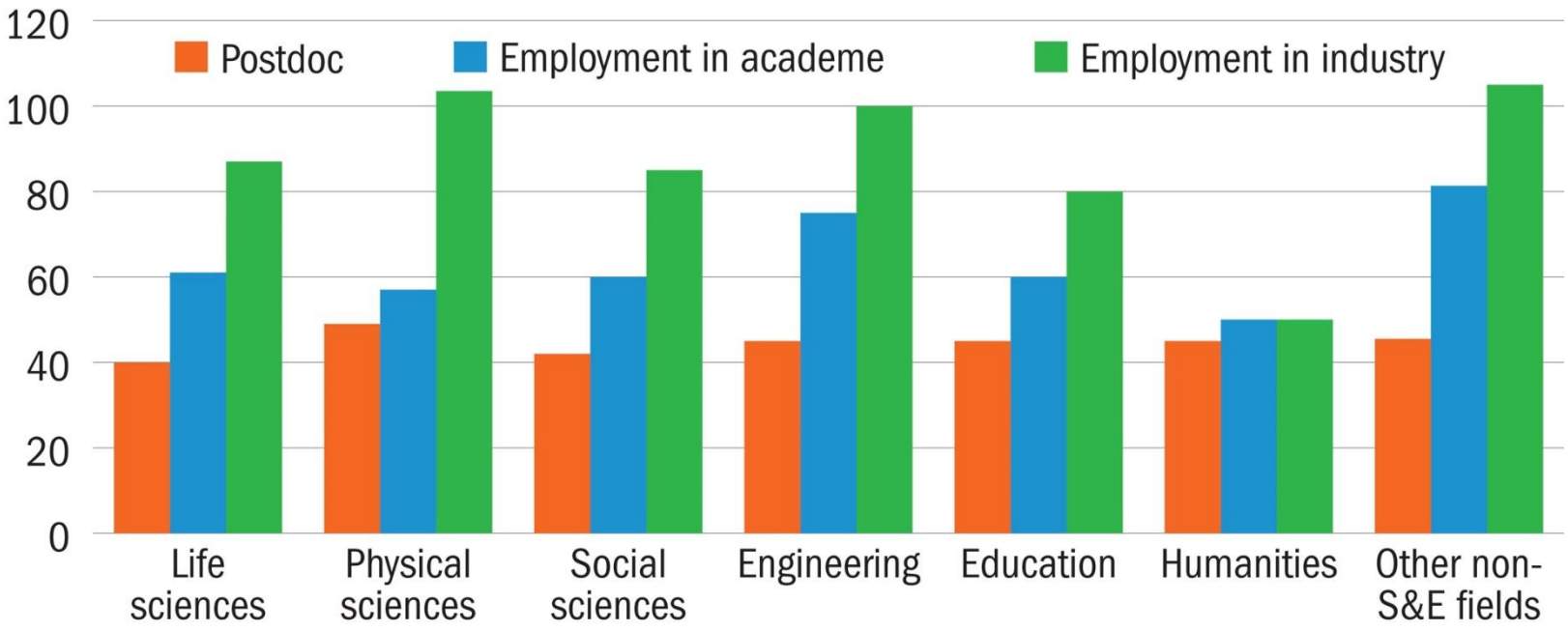


Stephan, *How Economics Shapes Science*

Role of Publications

Publications—especially first authored articles in high impact journals-- are necessary condition for getting out of post doc jail into an academe position

Median basic salary of doctorate recipients with definite commitments in the United States, by position type and field of study: 2014



NOTES: Other non-S&E fields includes business management and administration.
Employment in industry includes doctorate recipients who indicated self-employment.
Related detailed data: tables 48, 49.

In addition to low pay

- Long hours—average number per year reported to be 2650 in the biomedical and physical sciences
- About 100 hours less in engineering
- Until recently many postdocs lacked fringe benefits; some still do

Stephan, *How Economics Shapes Science*

Arms Race

- Working to get top publications that make one stand out from other postdocs;
- First author extremely important
- Mike Lauer, Deputy Director Extramural Research NIH, refers to this as the “Arms Race Component”

Lucky few no longer “young” by time they enter academic career

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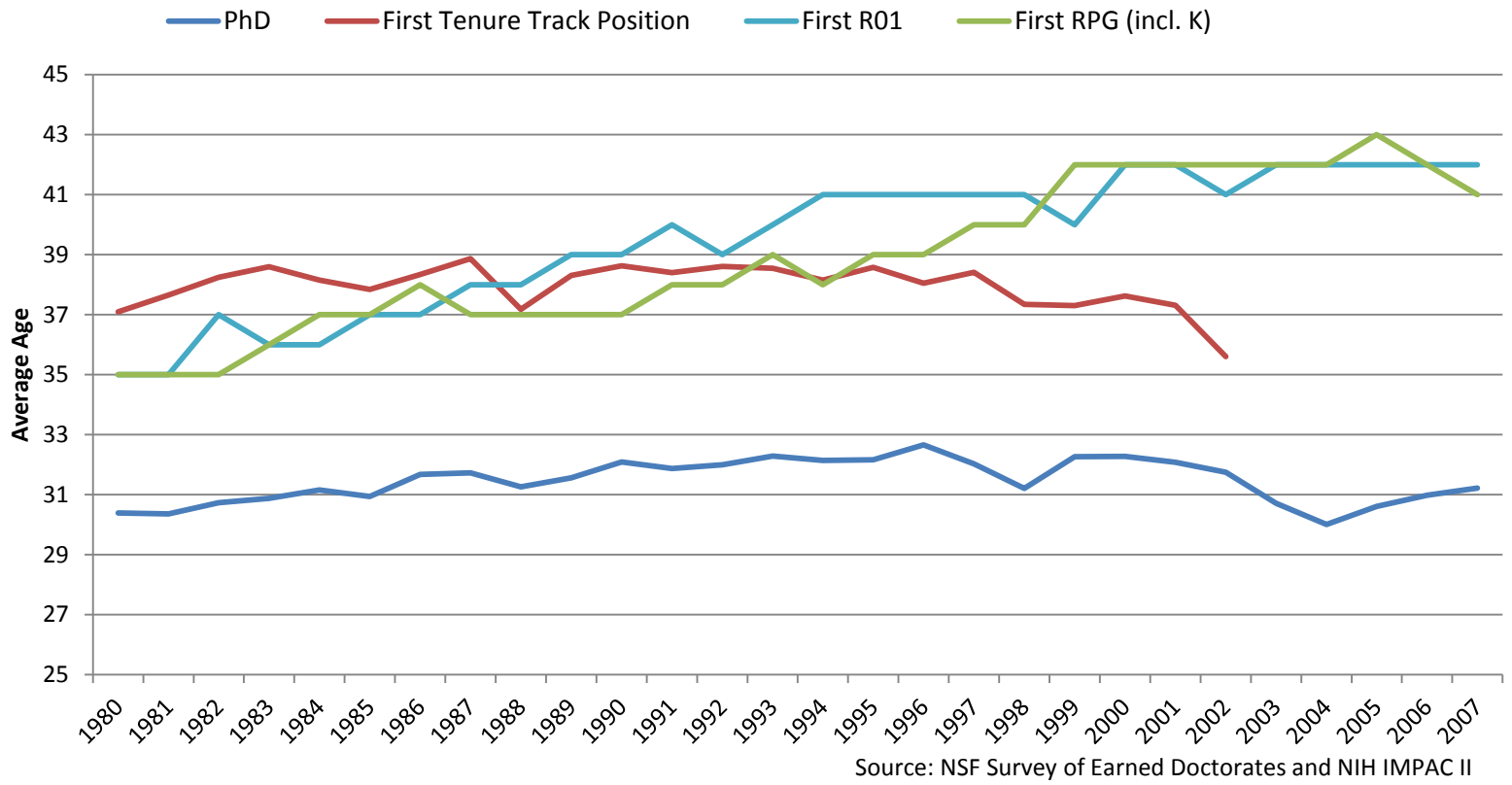
Biomedical Doctorate Academic Career Milestones, by Age



- There is a increasing divergence between age at PhD and age at first R01/RPG for biomedical doctorates
- There appears to be a decoupling of tenure track jobs and first R01/RPG

Majority new PhDs will work in industry

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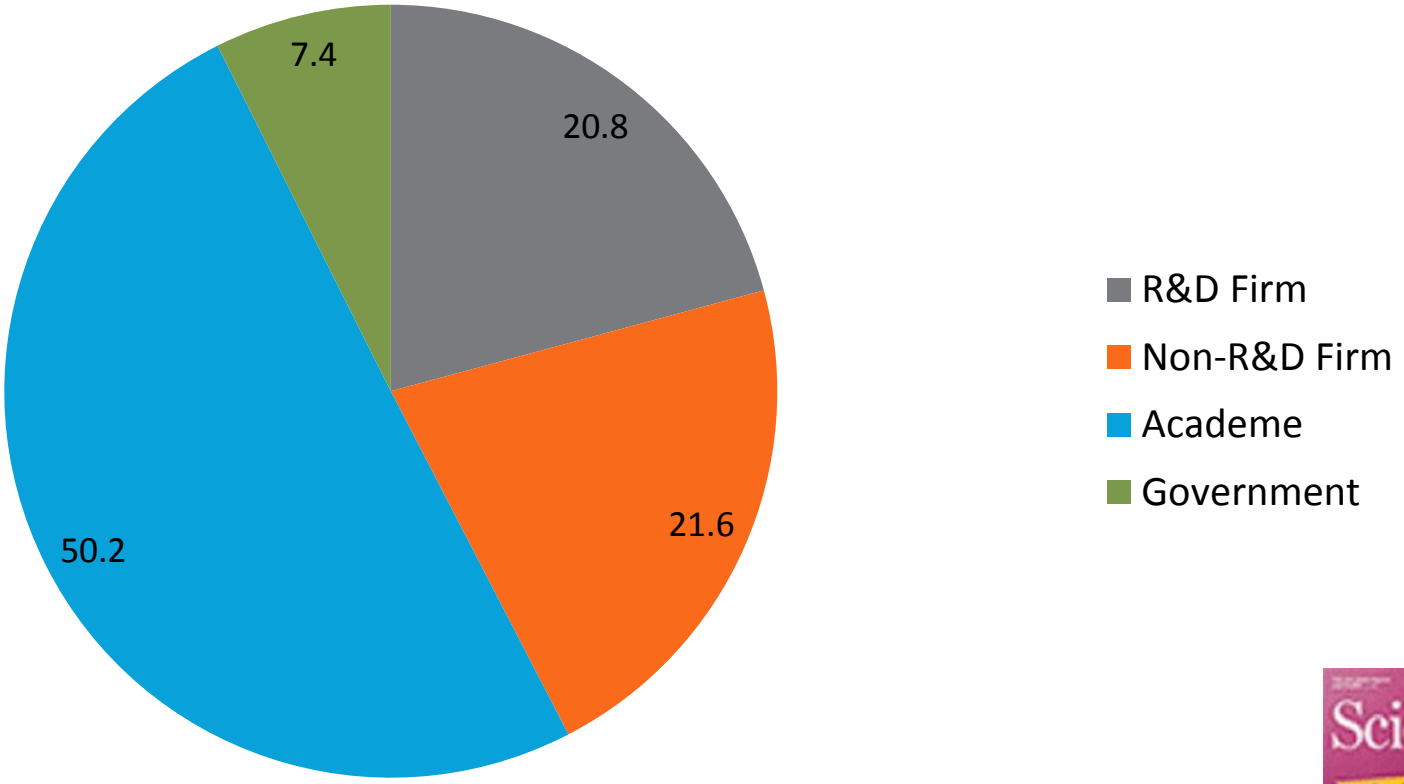
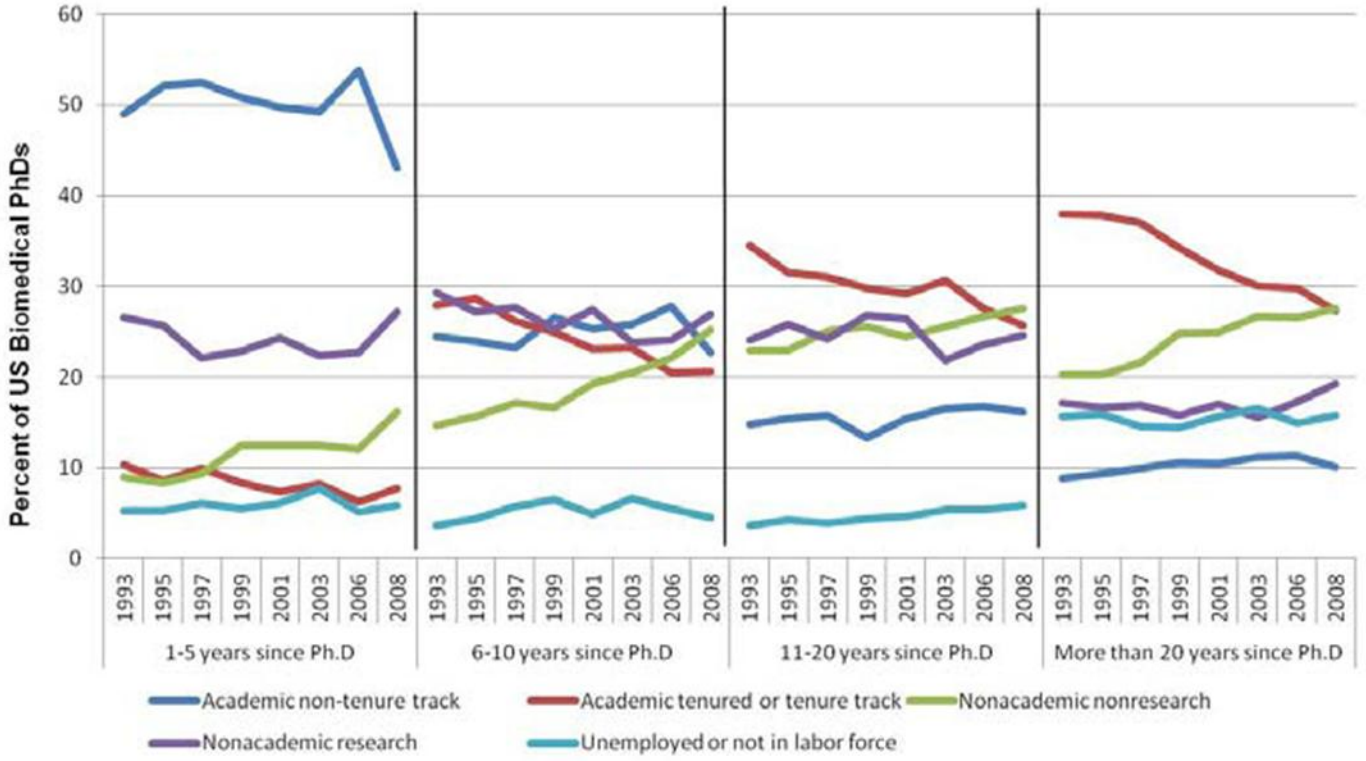
Placement Outcomes
PhD Recipients Supported on Grants



Zolas et al. 2016;
UMETRICS; 8 Universities

Employment Outcomes by Cohort Biomedical Sciences



Charts produced for NIH 2012 Workforce Report

Implications for publishing

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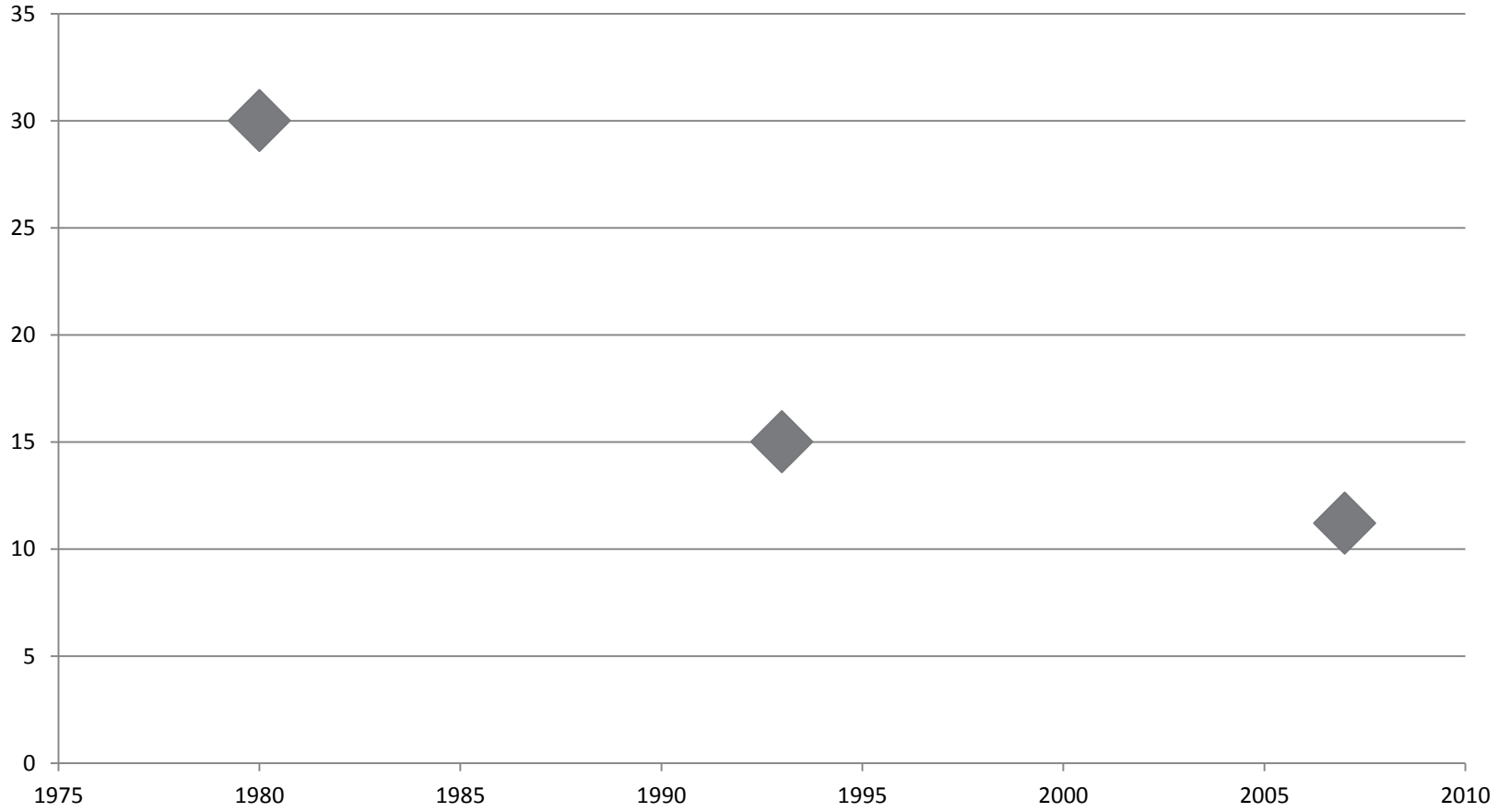
Many Industrial Placements Not in R&D Firms

- Half of those UMETRICS study
- Half of firm placements for 6-10 year cohort in NIH Workforce Study.
- Even scientists working in R&D firms are now less likely to publish

Percent of R&D Firms Publishing



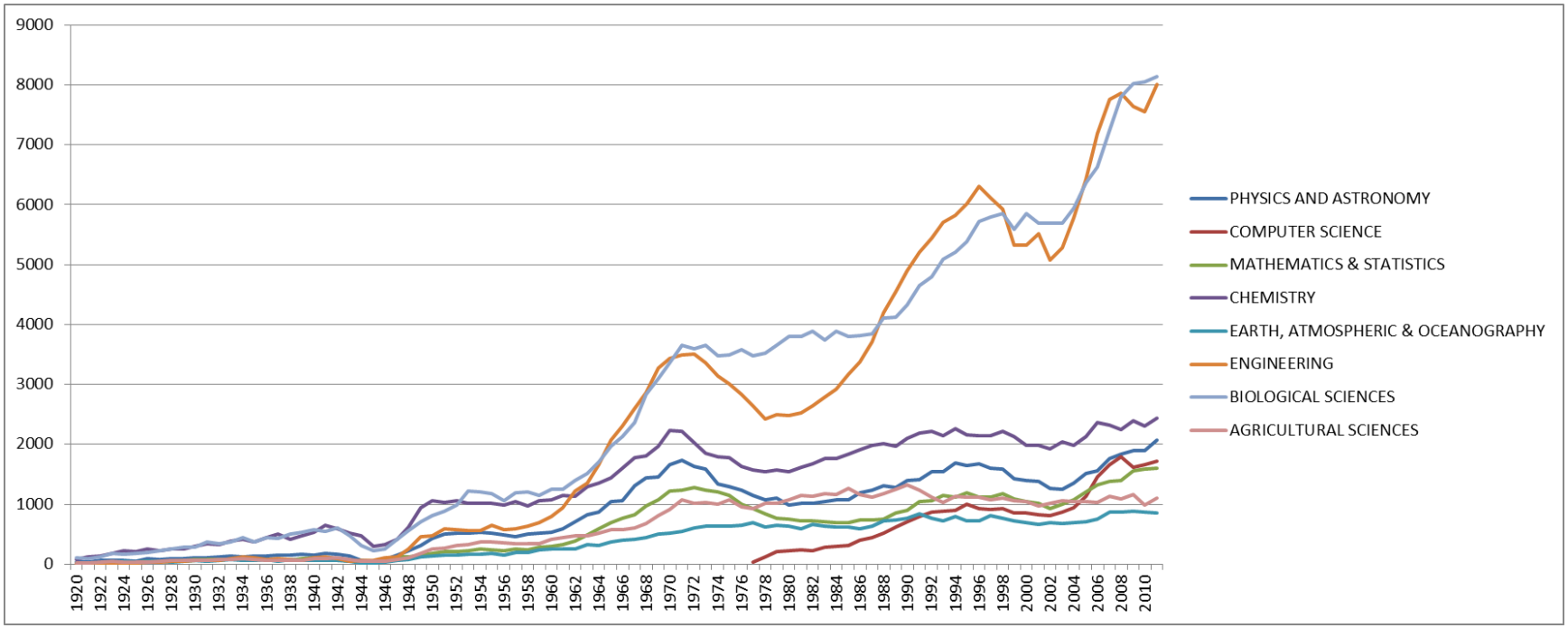
KILLING THE GOLDEN GOOSE? THE DECLINE OF SCIENCE IN CORPORATE R&D Ashish Arora, Sharon Belenzon, Andrea Patacconi

Drivers of This

- Decline of large basic-research intensive labs
  - DuPont
  - Bell Labs
- More applied research
- Narrower scope
- “Outsourcing”

Despite trends, US is educating and training more and more PhDs

PhD Production: 1920-2011



Compiled from administrative records and the SED

Why?

US Universities Operate like High-end Shopping Malls

- Business of building state-of-the art facilities and reputation that attracts good students, good faculty and resources
- Lease facilities to faculty in form of indirect costs on grants and buyout of salary
- Faculty receive start-up-funds when hired
- Many faculty “pay” for the opportunity of working at university, receiving no guarantee of income if they fail to bring in a grant

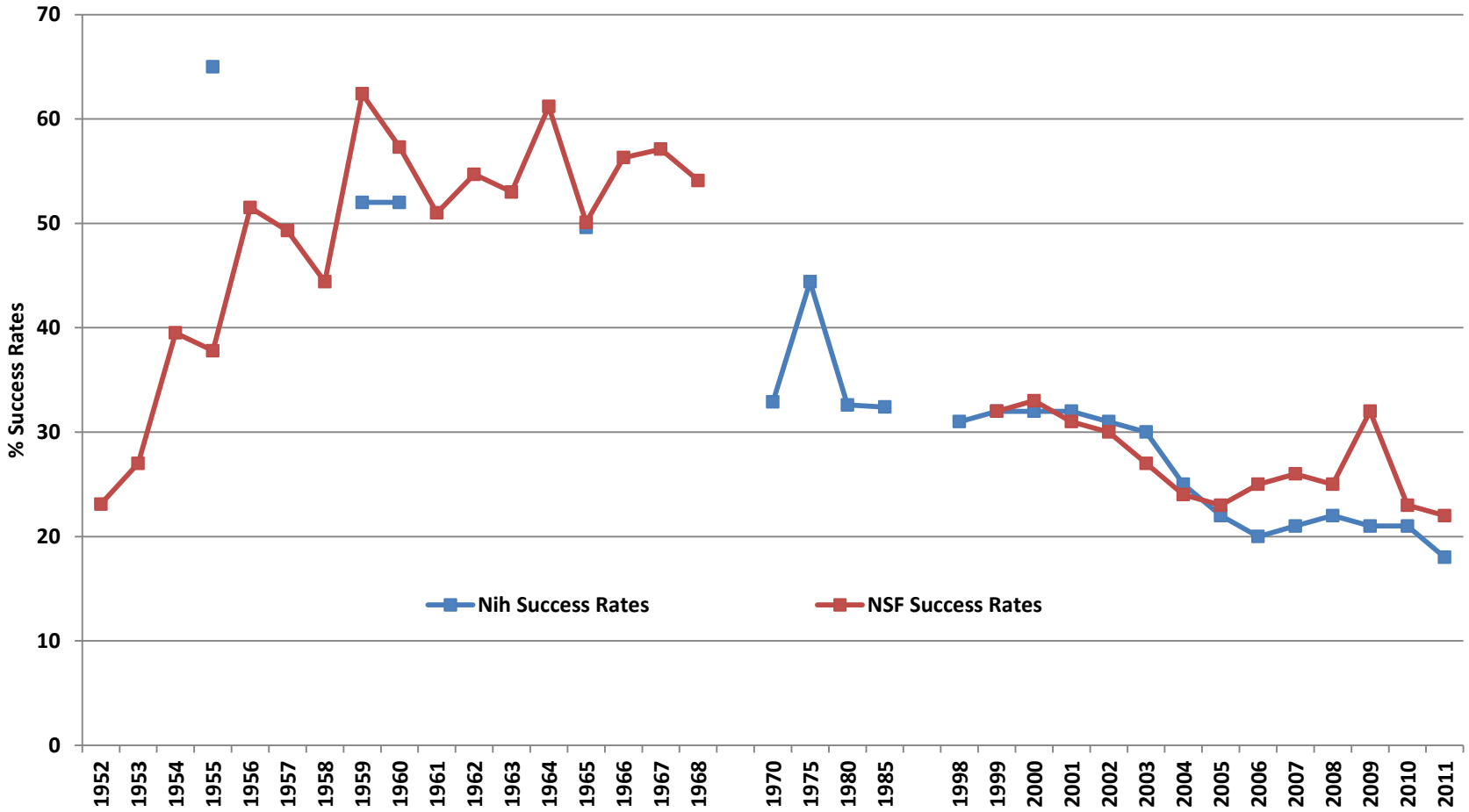
Shopping Mall Model Means Funding All Important for PIs

- Requirement for keeping their space in the mall, and for many, their salary
  - "Funding or Parish"

Steven Quake, Stanford

- Spend considerable amount of time writing and administering grants
- Do this in an environment that has become increasingly competitive

NIH and NSF Success Rates Available Years



NSF rates for 1952-1968 are for the Division of Biological and Medical Sciences

Focus on Grant Seeking

- Raises importance of having other people to work in lab—PI's time diverted to grant preparation
  - PIs on Federal grants spend 42% of research time in grant-related administration (Kean survey)
- Importance of funding raises importance of publications given key role publications and their associated bibliometrics play in grant review and grant success

Response of PI's

- Staff labs with postdocs and graduate students
  - Young
  - Full of ideas
  - Temporary
  - Cheap: postdoc costs about $16.50 an hour; graduate students about $20.00 (before fringes and indirect); staff scientist costs about $32.00 per hour.
  - Funds have been available for these positions on grants
  - "Can be fired"

No surprise graduate students and postdocs play a key role in publishing

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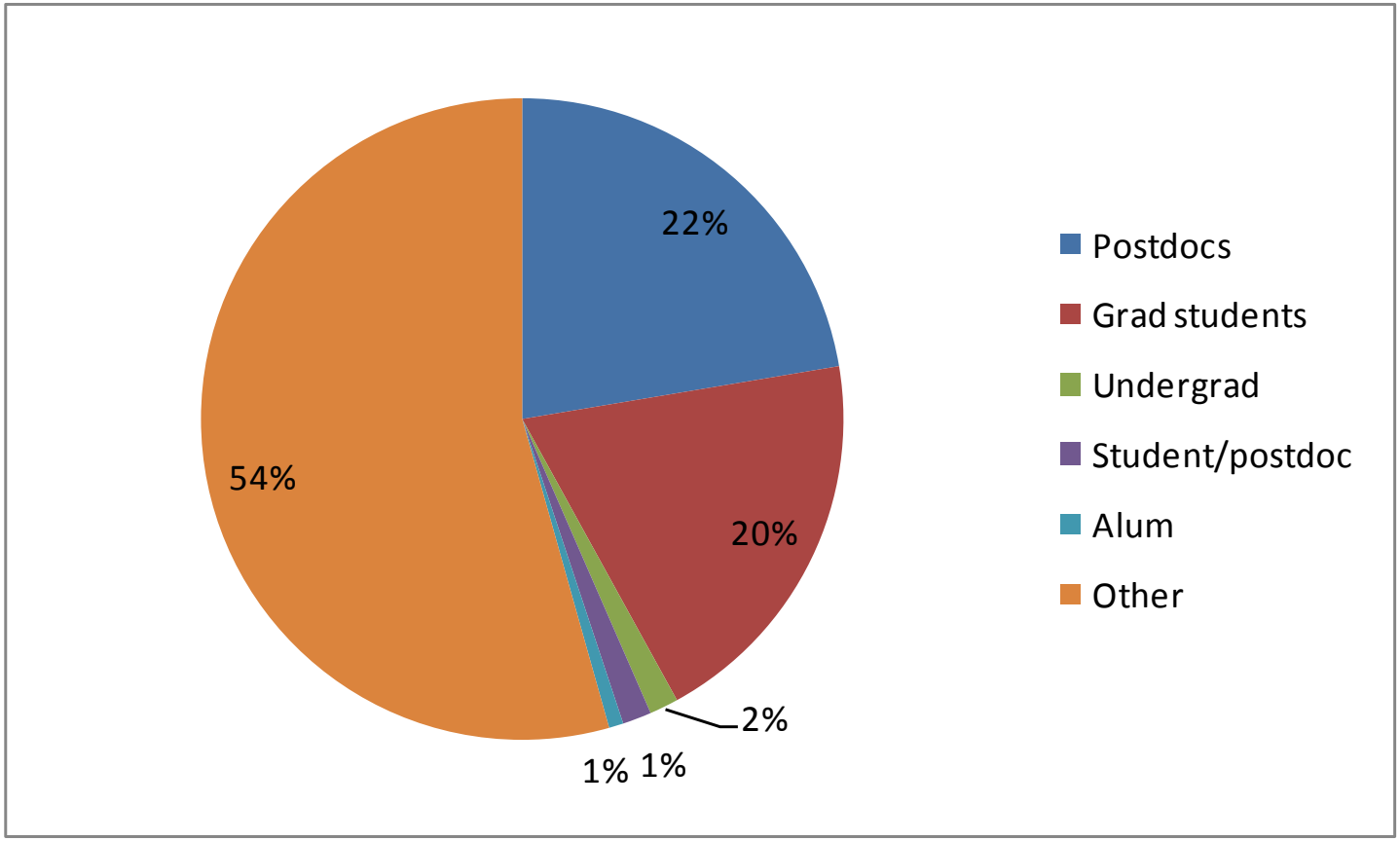
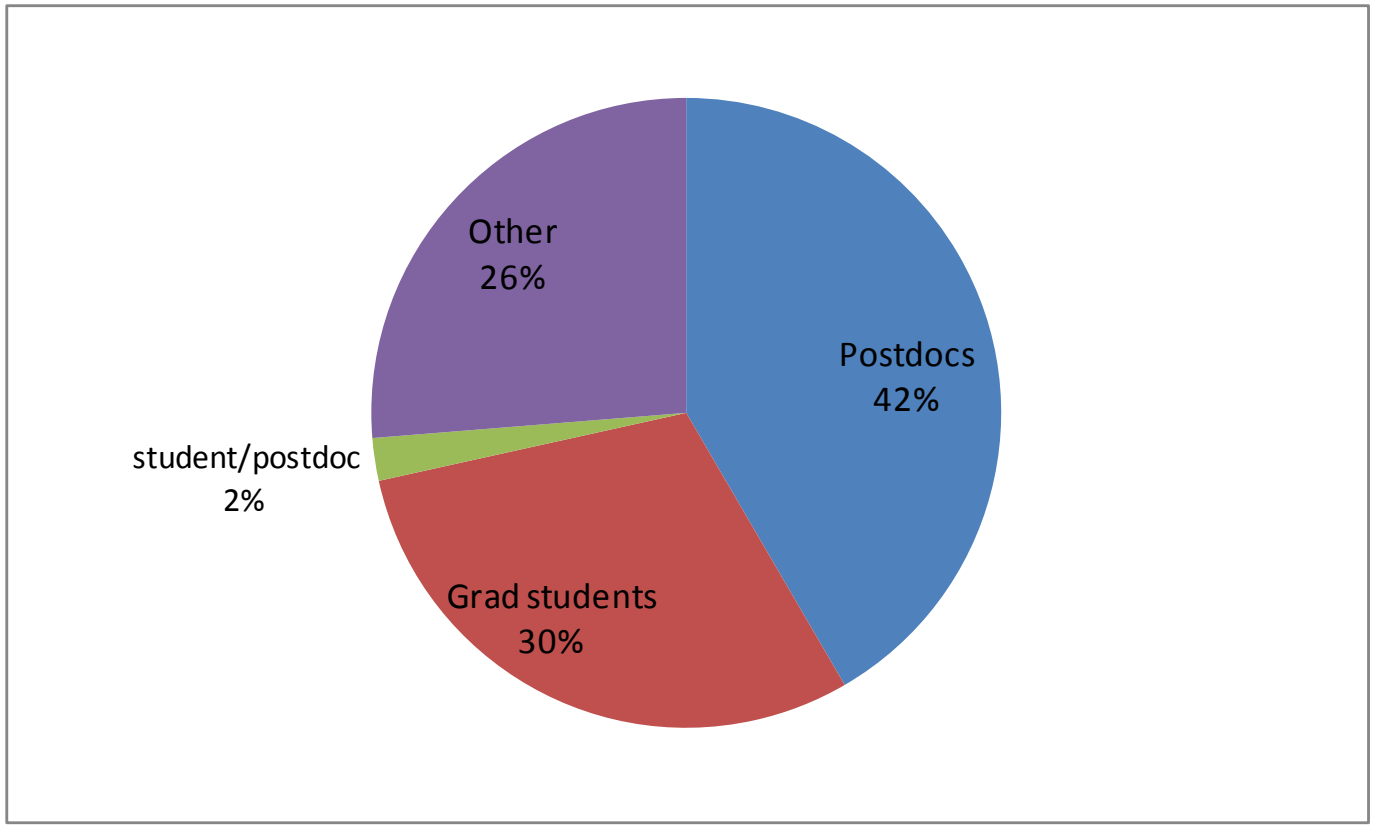
Postdocs and Graduate Students: coauthors in *Science*



Black and Stephan 2009

First Author: *Science*



Black and Stephan, 2009

Copy Cat Behavior

- If shopping mall model works for science and engineering,
- Why not for social sciences and humanities!
- Pressure to bring in grants in these fields; hiring more temporary staff; increasing number of postdocs

Copy Cat Behavior Abroad

- Funding has become increasingly important in many countries, such as Belgium, France, the UK, Italy,
- Publication plays a major role in the evaluation process
- Publications play a major role in exiting postdoc position

Shopping Mall Model

- Lead to some perverse incentives
  - Creating more PhDs than demand for researchers
  - Risk aversion

Risk Aversion

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Risk Aversion

- Concern that scientists avoid risk by submitting proposals they see as “sure bets”
- Why?
  - In order to keep one’s lab functioning one must have external support; university only supports lab for 3 to 4 years
  - Need for faculty to obtain grants to support their salary—especially important for faculty on soft money—perhaps 35% of NIH investigators –no funding, no job!
  - Low probability of success – currently 17 to 20 percent at NIH depending on institute (there are 27)
  - Reviewers prefer proposals with convincing preliminary data: “no crystal, no grant.”
  - To quote Nobel laureate Roger Kornberg, “If the work that you propose to do isn’t virtually certain of success, then it won’t be funded.”

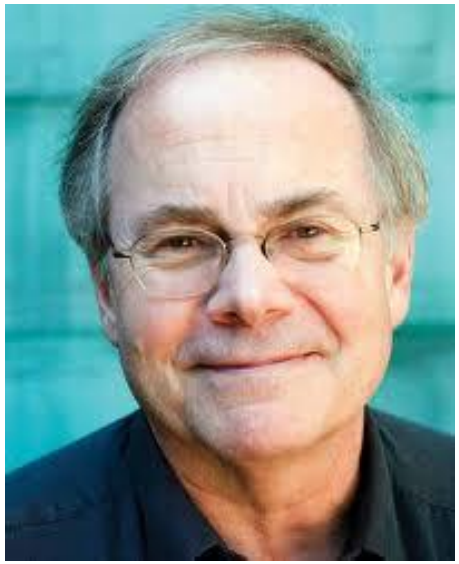
Other Factors that Contribute to Risk Aversion

- Short term nature of grant—3 to 5 years (3.5 is average length)
  - Hard to recover in this short period of time from a "failure"
  - Note that system funds projects, not people
- Ability to continue a line of research—some continue a line for over 40 years—incentives to do so—continuations-- have higher success rates

Costs of Risk Aversion Arguably High

- Pretty clear that if most scientists are risk averse little chance that transformative research will occur, leading to significant returns from investments in research and development.
- Incremental research yields results, but in order to realize substantial gains need more people doing transformative work.

“Goodbye, Columbus”



- Gregory A. Petsko
- Formerly at Brandeis University; currently Weill Cornell Medical School
- “Explores” reasons why Columbus’s proposal “Finding a New Route to the Indies by Sailing West” is (hypothetically) rejected
- *Genome Biology* 2012 13:155

PNAS

- Alberts, Kirschner, Tilghman and Varmas
- “Rescuing US Biomedical Research from Its Systemic Flaws”

Bibliometrics and Risk Aversion

- Heavy reliance on short-term bibliometric measures arguably reinforces risk aversion when it comes to funding individuals as well as promoting people

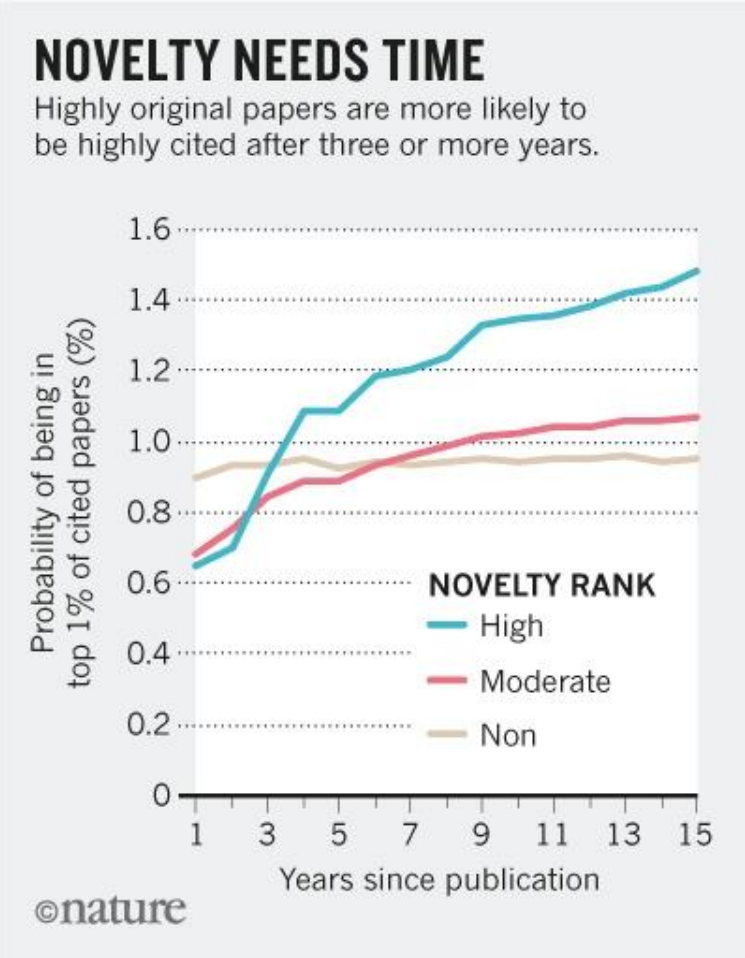
Blinkered by Bibliometrics

- Recent Comment in *Nature* with coauthors explores concern of how bibliometrics reinforce risk aversion
  - Jian Wang
  - Reinhilde Veugelers
- *Nature Comment,* April 26, 2017

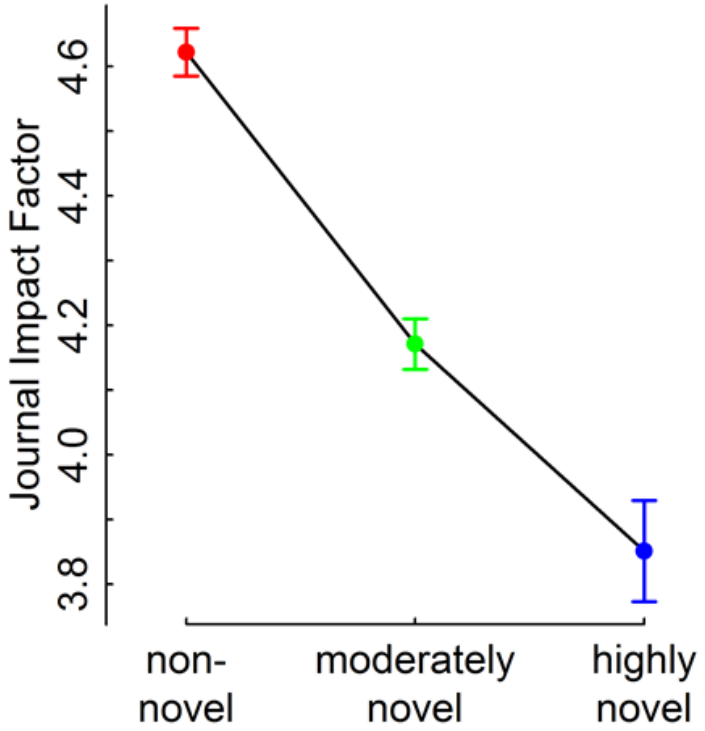
Premise

- Novel research that combines streams of knowledge never combined before, is risky; more likely to be frontier shifting; also more likely to fail
- Operationalize it by looking at number of first ever journal pairs in references of papers in 2001
- Find novel research is rare—11%; highly novel, much rarer

Findings


NOVELTY NEEDS TIME
Highly original papers are more likely to be highly cited after three or more years.
Probability of being in top 1% of cited papers (%)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
1
3
5
7
9
11
13
15
Years since publication
NOVELTY RANK
High
Moderate
Non
©nature

Highly Novel Papers Published in Journals with Lower Impact Factor than Predicted



Wang, Veugelers and Stephan, 2017

Implication

- Heavy reliance on short term bibliometric measures (such as using 2 year Impact Factor) and recent citations biases funding decisions against investigators doing novel research
- Yet some funding agencies require such bibliometrics be reported in the grant
- Reviewers are sorely tempted by “quick” metrics such as

Summary

- Supply of PhDs growing and greater than demand for research positions, be they in academe or industry
- Implications for publishing
  - Postdocs under tremendous pressure to publish
  - Faculty under pressure to publish; not only for tenure but to retain their place in the mall
  - Incentives discourage risk taking in type of research that is funded and carried out
  - Industry, which is hiring a larger percent of PhDs than in the past, is publishing less

Outlook for Academe

- Unlikely that public funds for research will grow substantially; in some fields decline
- Administration has proposed cutting indirect rate
- Universities, especially public universities, are being particularly squeezed by loss of funds from states
- New revenue streams may be difficult to find— "out-of-state/foreign student premium" may be just about exhausted
- Some growth in funds from private foundations;
  - Much of this focused on applied research rather than basic research; "cure oriented"

Can the Shopping Mall Model Survive?

- Serious cracks in the model
- Not just universities that are having problems

The Retail Model is Having Problems

- ***Is American Retail at a Historic Tipping Point? New York Times, April 15, 2017***

Similar Question

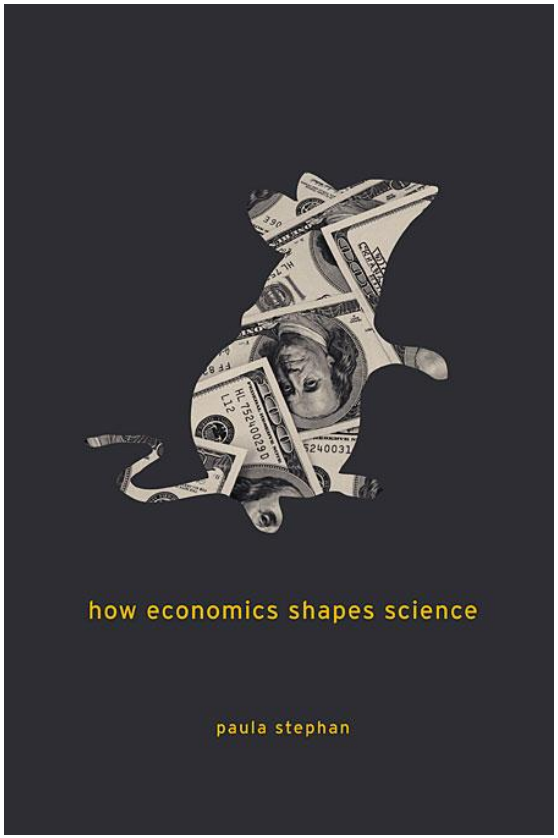
- Is academe reaching a tipping point?

Questions/comments

- pstephan@gsu.edu

Drawn from

Recently published in paper



Comment in *Nature*

Research efficiency: Perverse incentives

And

"The Endless Frontier: Reaping what Bush Sowed?"