

# Evidence-Based Funding: Thoughts About Extramural Research

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Deputy Director for Extramural Research  
National Institutes of Health

Plenary: Meeting of the Federal Demonstration Partnership (FDP)  
Thursday, May 5, 2016  
Hyatt Regency Capitol Hill, 400 NJ Avenue, Washington, DC  
Disclosures: None



## Opinion: Celebrating R and D expenditures badly misses the point

**Daniel Shapiro<sup>a,1</sup> and Kent Vrana<sup>b</sup>**

<sup>a</sup>Department of Humanities, Pennsylvania State College of Medicine, Hershey, PA 17033; and

<sup>b</sup>Department of Pharmacology, Pennsylvania State College of Medicine, Hershey, PA 17033

akin to an airline proclaiming, “we use more gasoline than any other airline!” or “we spend more per year transporting our passengers!” Consider the appearance and potential con-



# The Best Breakfasts in America

PLUS  
THE MOST  
IMPORTANT  
MEAL?  
BREW  
BETTER  
COFFEE  
THE  
CELEBRITY  
BREAKFAST  
CLUB  
SCRAMBLE  
BETTER EGGS  
BACON,  
JUSTIFIED

And an unforgettable  
tale about crab cakes

JANUARY 2016

## Mission Unchanged

“... same Mission and Purpose as we did in 1971 – to deliver People where they want to go, safely, ontime, with their bag, and with a smile ... With low fares and no hidden fees.”

Gary Kelly  
CEO

<http://swamedia.com/magazine>

- Where they want to go: % non-stops
- Safely: 0% major incidents
- On time: % of flights on time
- With their bag: % of checked bags lost
- With a smile: rate of complaints
- Low fares: comparable measure

# What Should Our Metrics Be?

## A New Finish Line

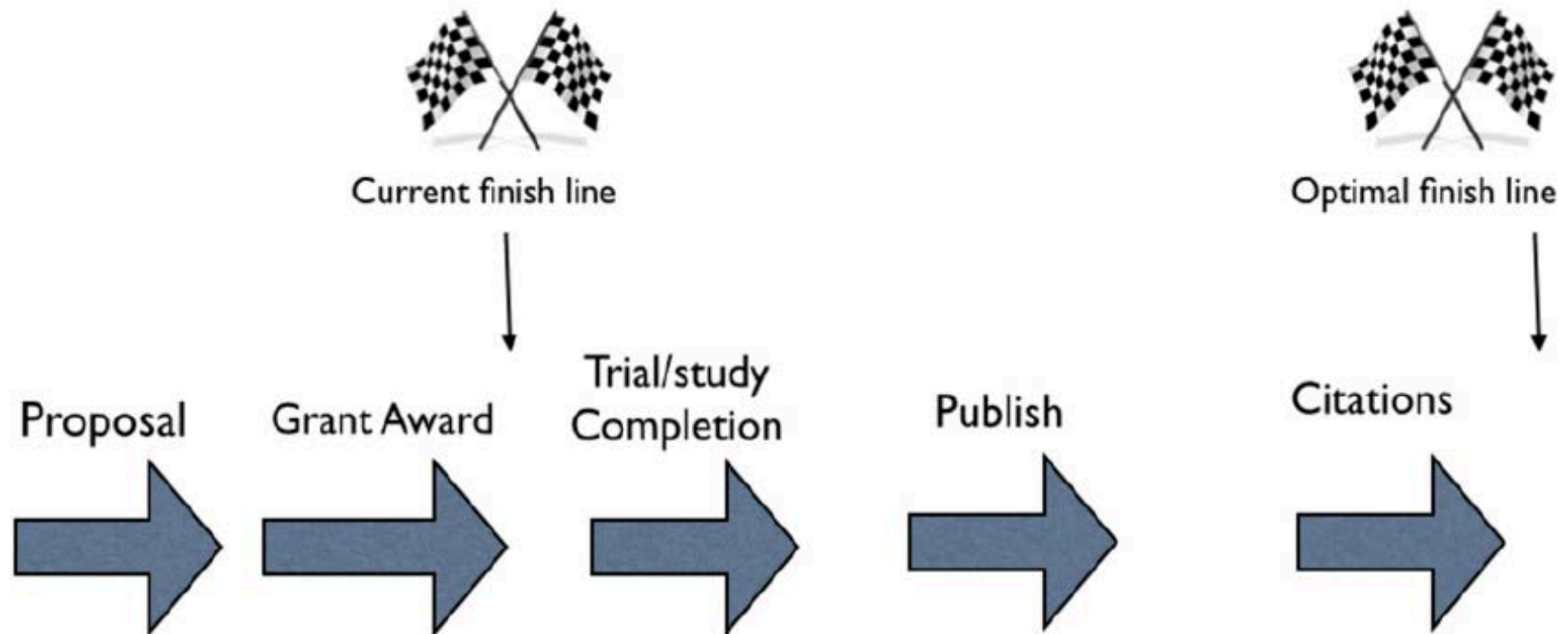
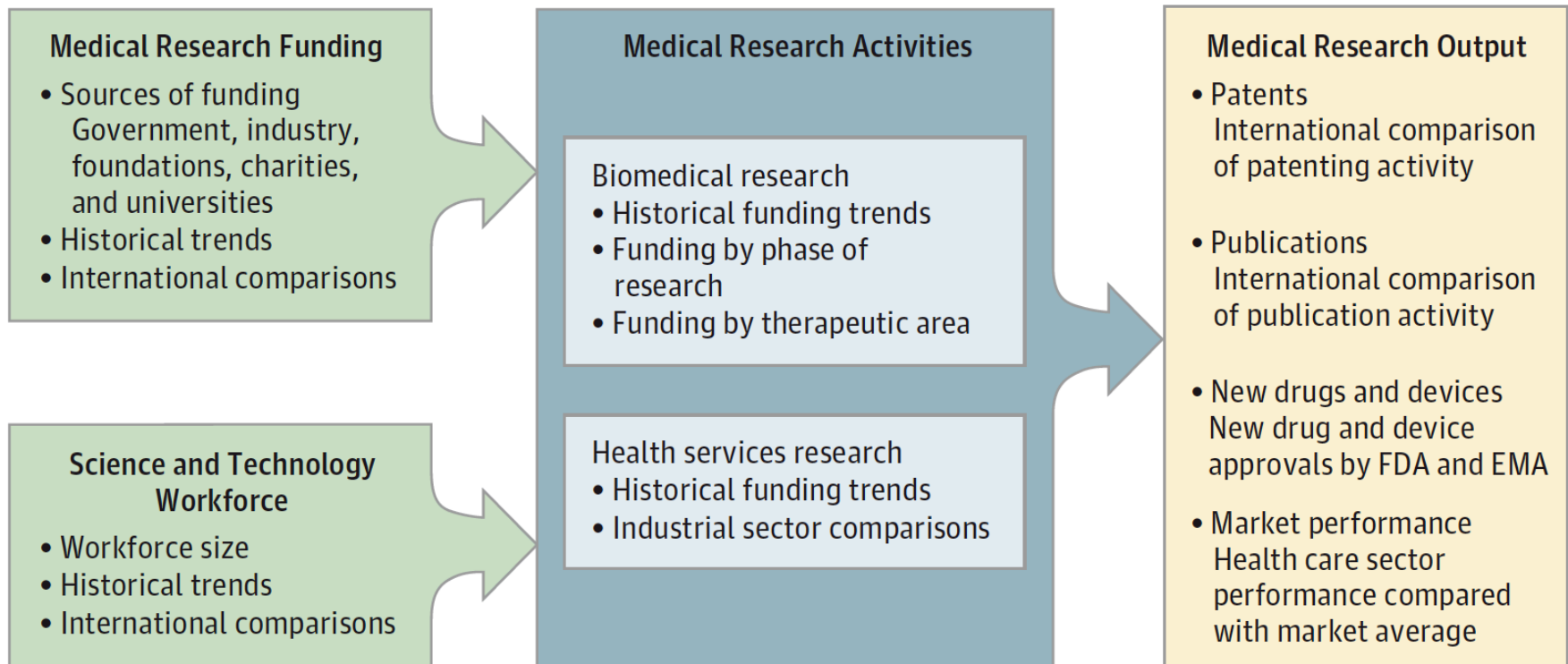


Figure 1. The Anatomy of Medical Research: US and International Comparisons





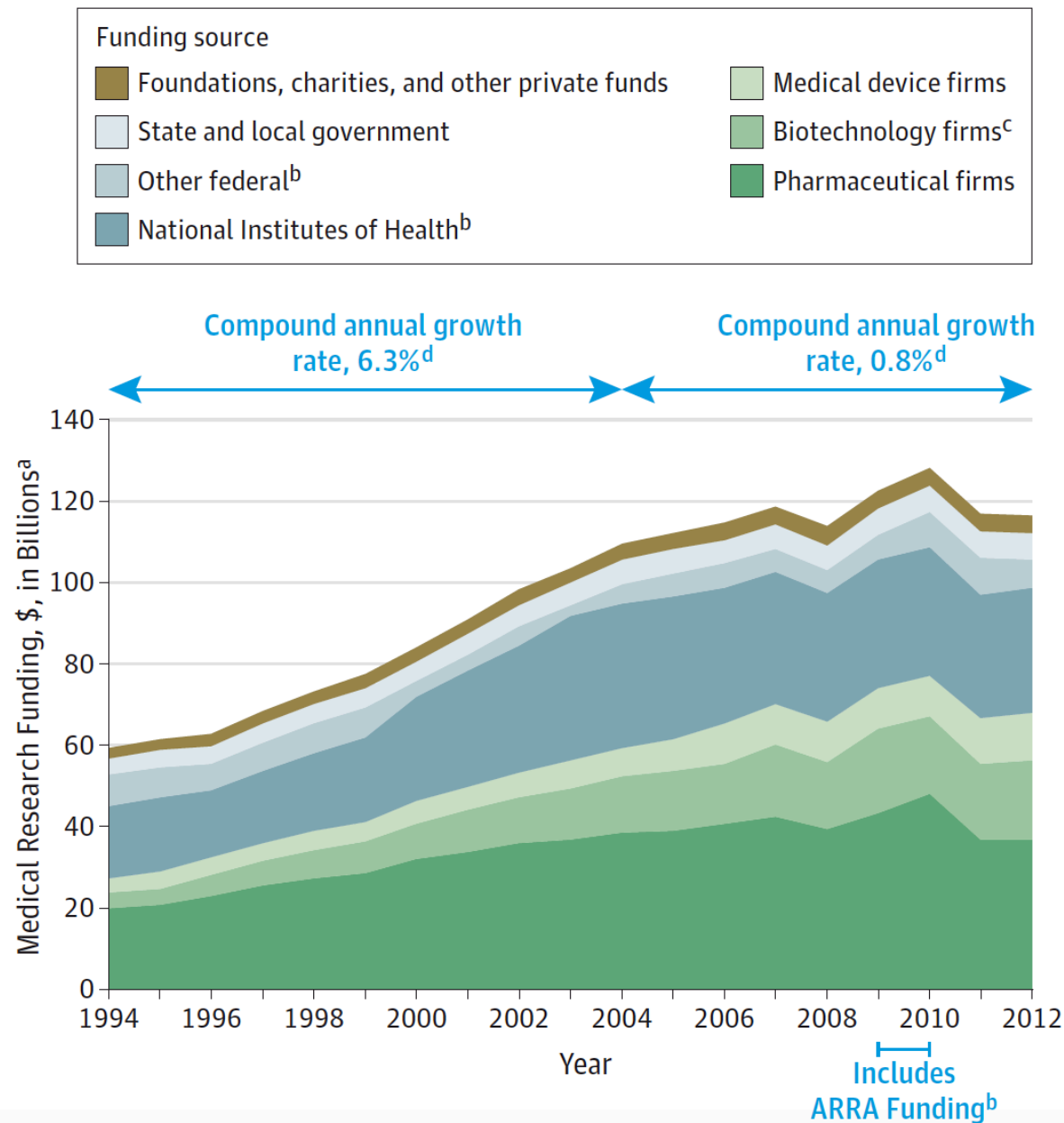
## Medical Research Funding

- Sources of funding  
Government, industry,  
foundations, charities,  
and universities
  - Historical trends
  - International comparisons
- 

Moses H et al. JAMA 2015;313:174-189



Figure 2. US Funding for Medical Research by Source, 1994-2012



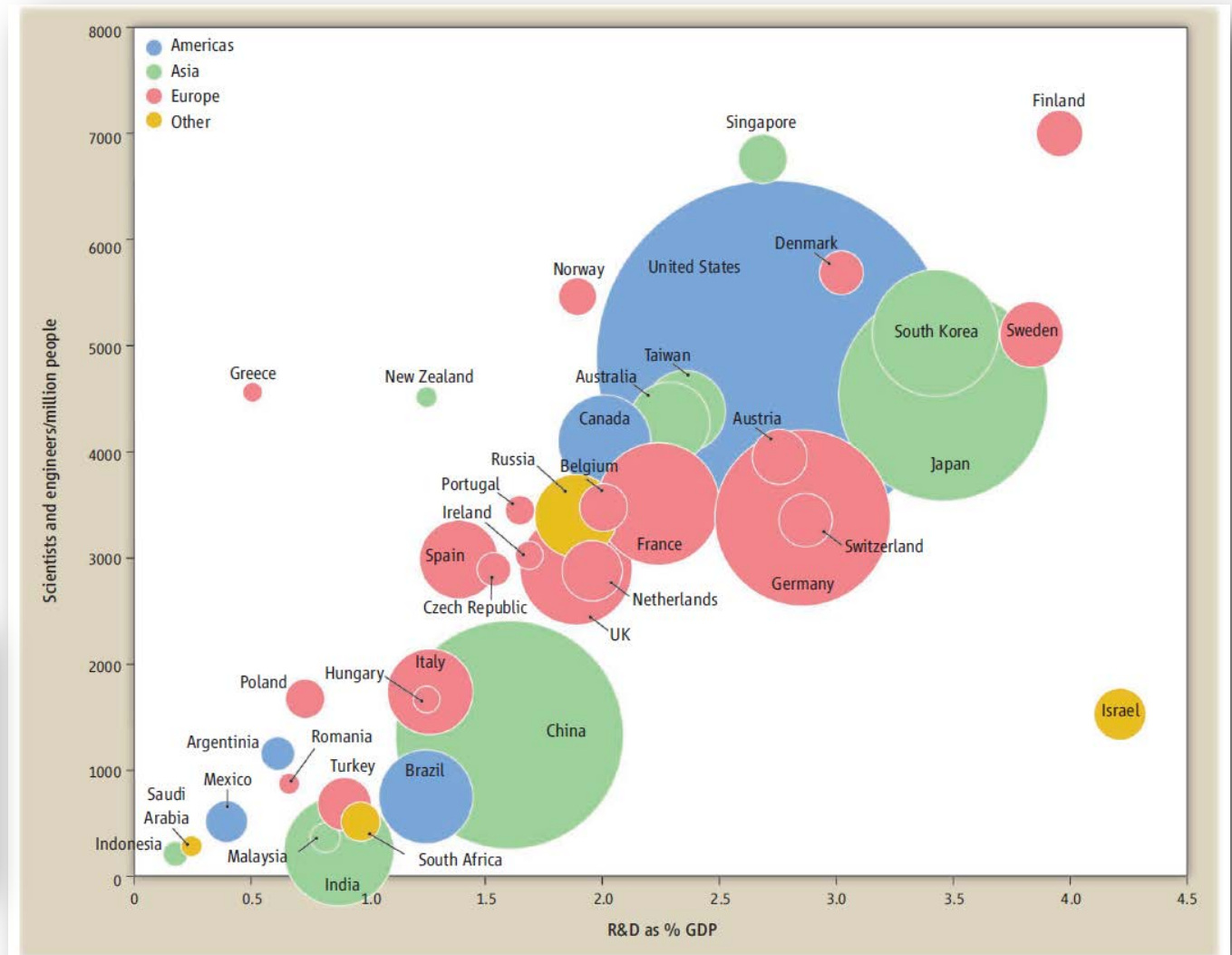
Stagnant ...

Annual Growth  
2004 – 2012:

Pharma -0.6%  
Device +6.2%  
Biotech +4.6%  
NIH -1.8%



# Another Perspective ...

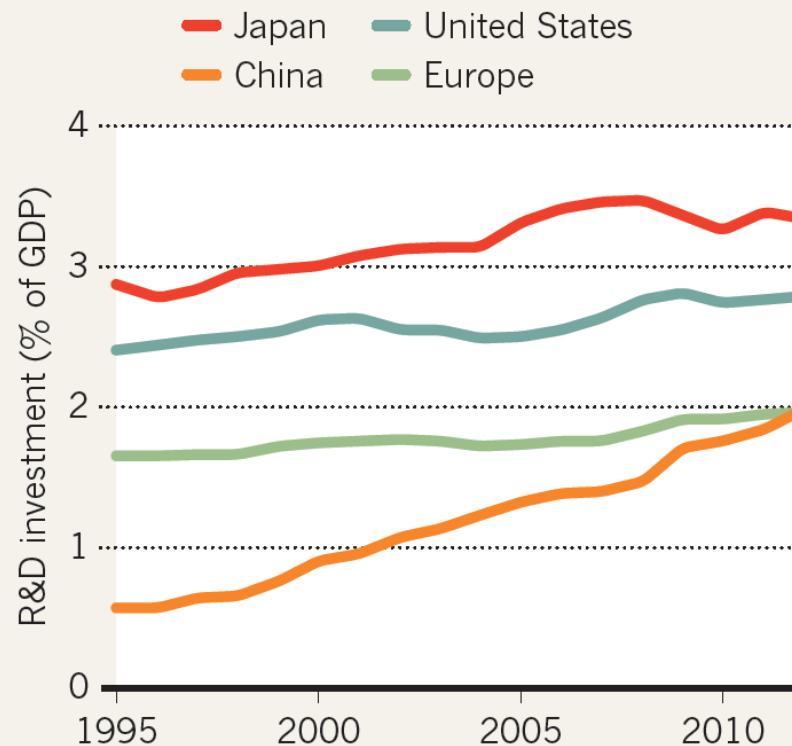


# China tops Europe in R&D intensity

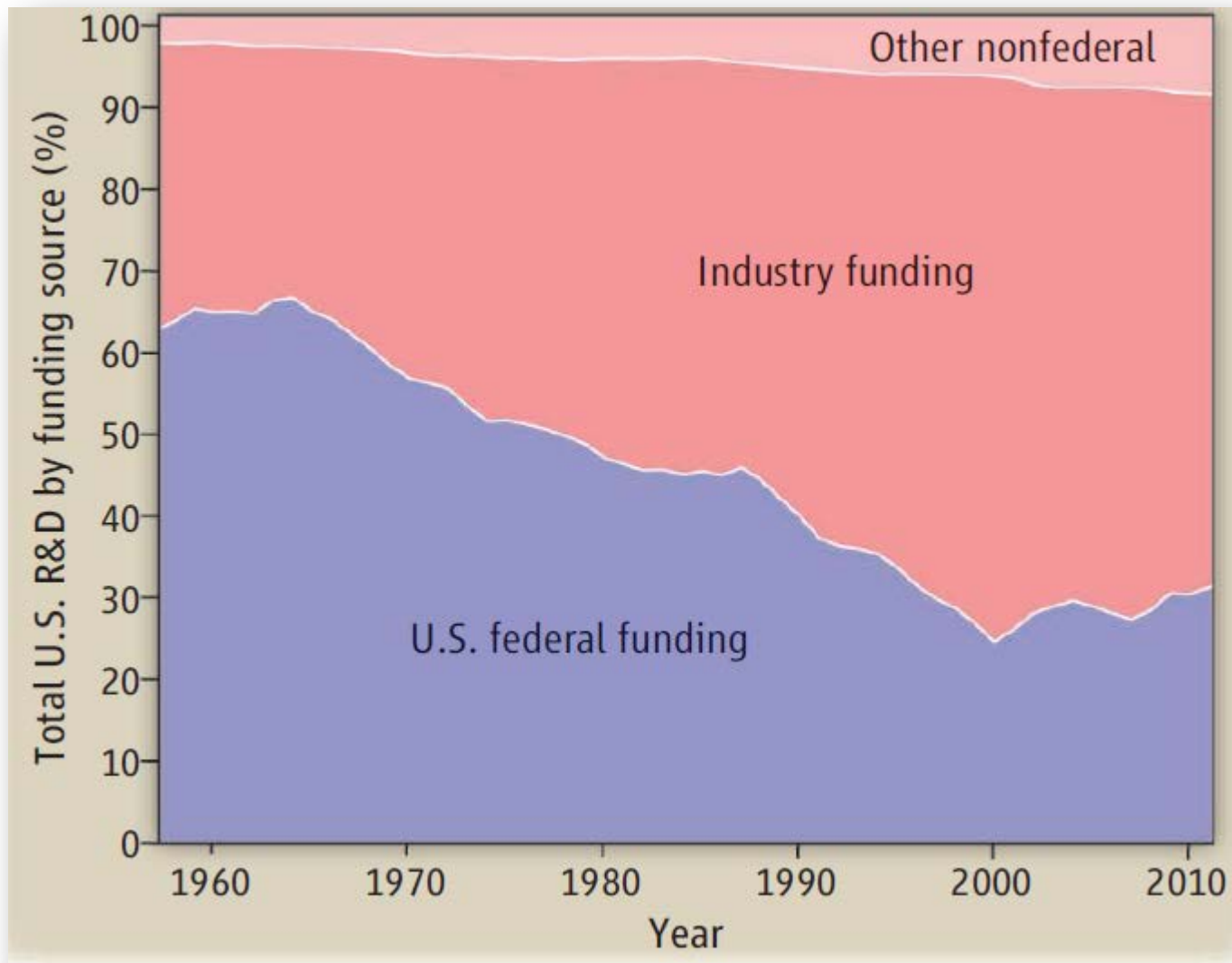
## Trends that Matter ...

### SHOOTING STAR

China has passed Europe in its investment in research and development (R&D) as a percentage of its gross domestic product (GDP).



# Perhaps the Most Important Trend ...



## Science and Technology Workforce

- Workforce size
- Historical trends
- International comparisons

Moses H et al. JAMA 2015;313:174-189



**Early career  
investigators**

**Reproducibility**

**Peer review**

**Diversifying Research**

**Distribution  
of funding**

**Efficiency**

**Academic  
business model**

**Stability and  
sustainability**

**Optimizing education**

**Maximizing chances  
for discoveries**

**Scientific  
rewards system**

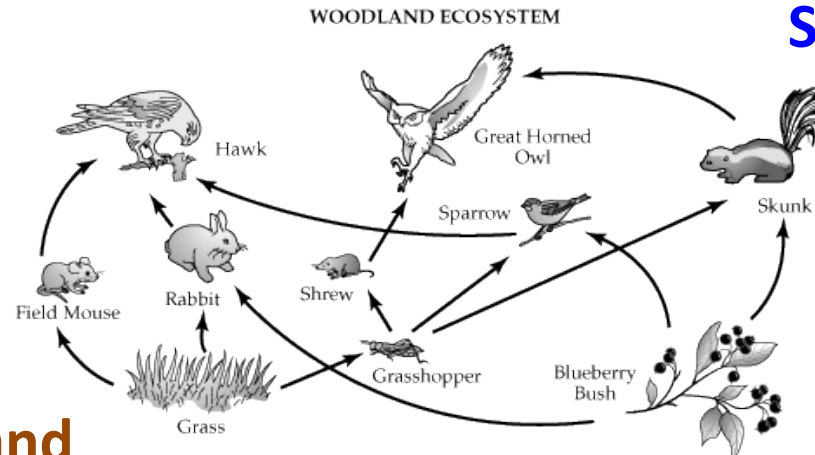
**Size of workforce**

**Promoting  
creativity and  
innovation**

**Are trainees students  
or workforce?**

**Post-doc.  
holding tank**

Thanks to Jon Lorsch



## Maximizing the return on taxpayers' investments in fundamental biomedical research

Jon R. Lorsch

National Institute of General Medical Sciences, National Institutes of Health, Bethesda, MD 20892

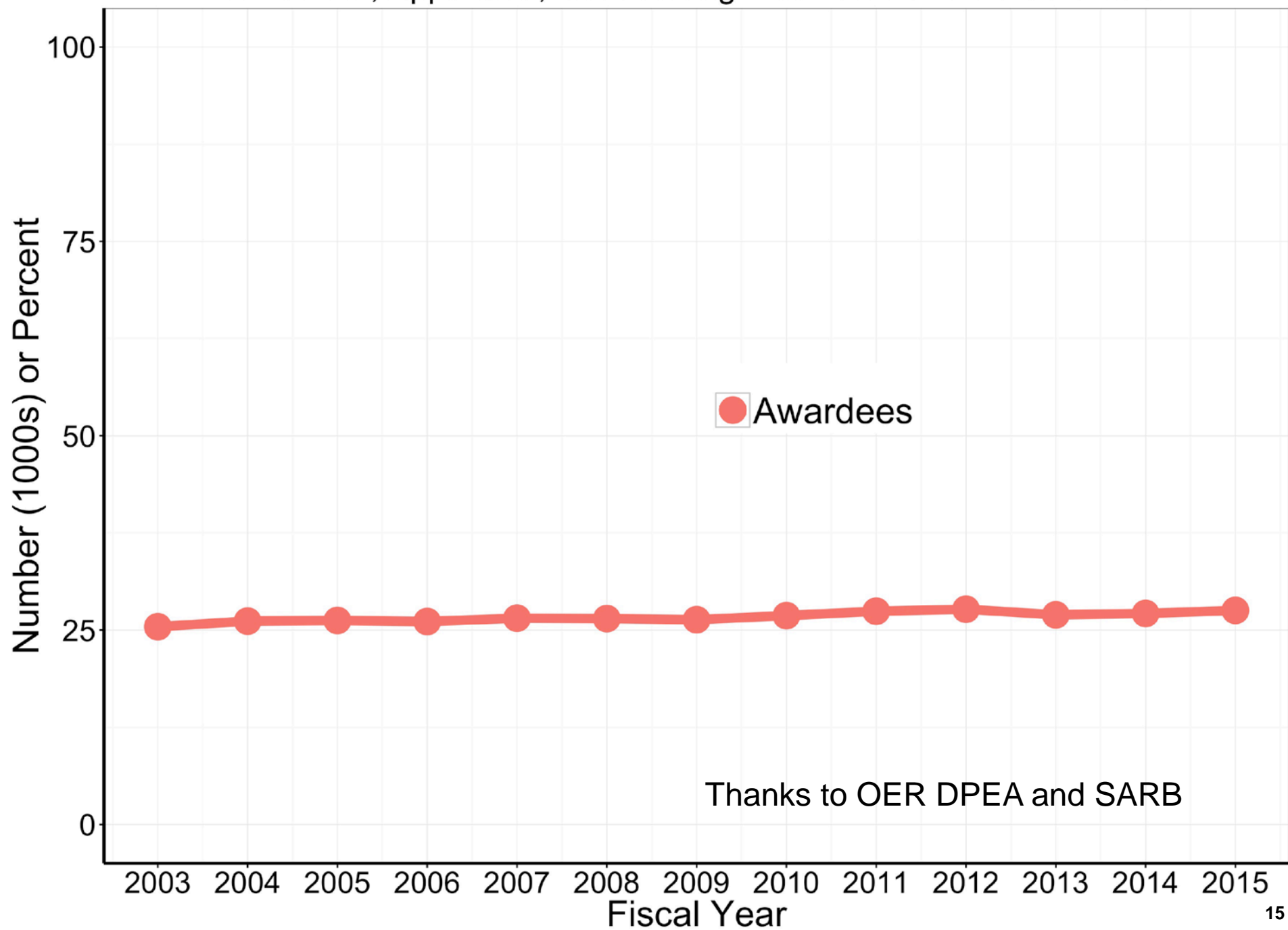
## Changing our funding metric

“A question that at first glance may seem trivial but is, I believe, a significant one is whether our key metric for how... we invest in ... research should be the number of grants we award or ***the number of investigators we support.***”

Lorsch JR. Mol Biol Cell 2015;26:1578-82



# Awardees, Applicants, and Funding Rates for all RPGs over Time



Awardees, Applicants, and Funding Rates for all RPGs over Time

Number (1000s)

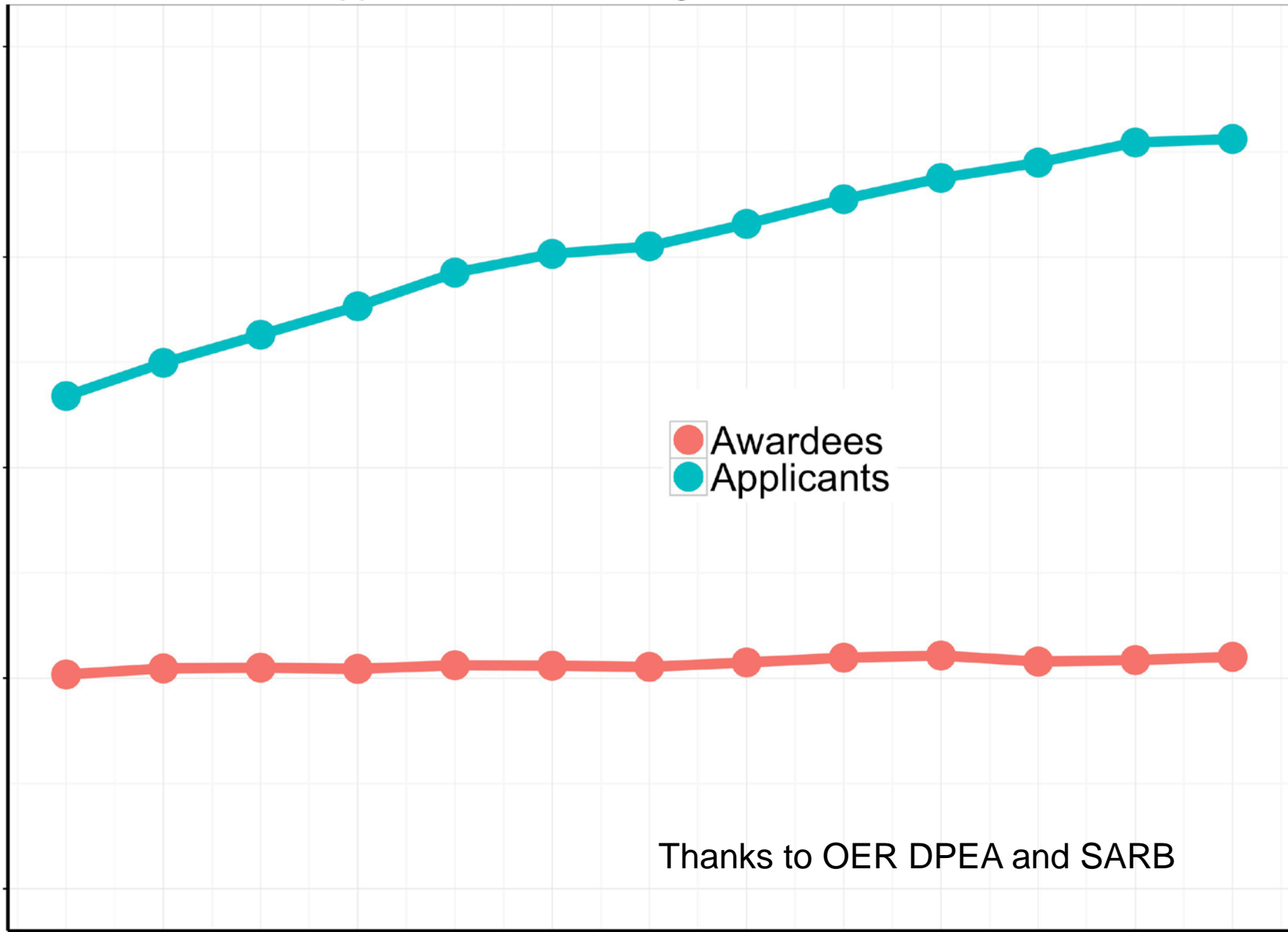
100  
75  
50  
25  
0

Awardees  
Applicants

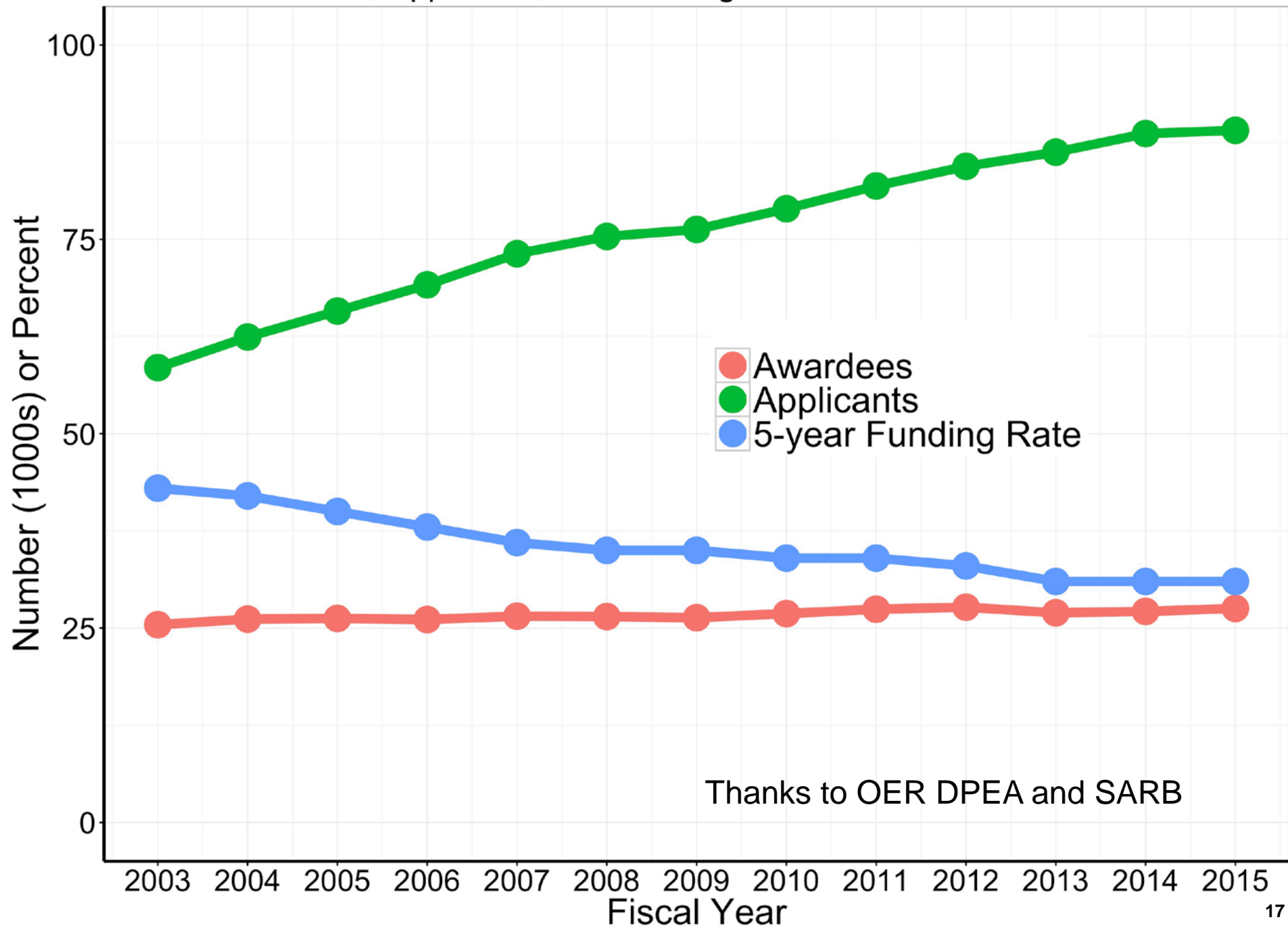
Fiscal Year

Thanks to OER DPEA and SARB

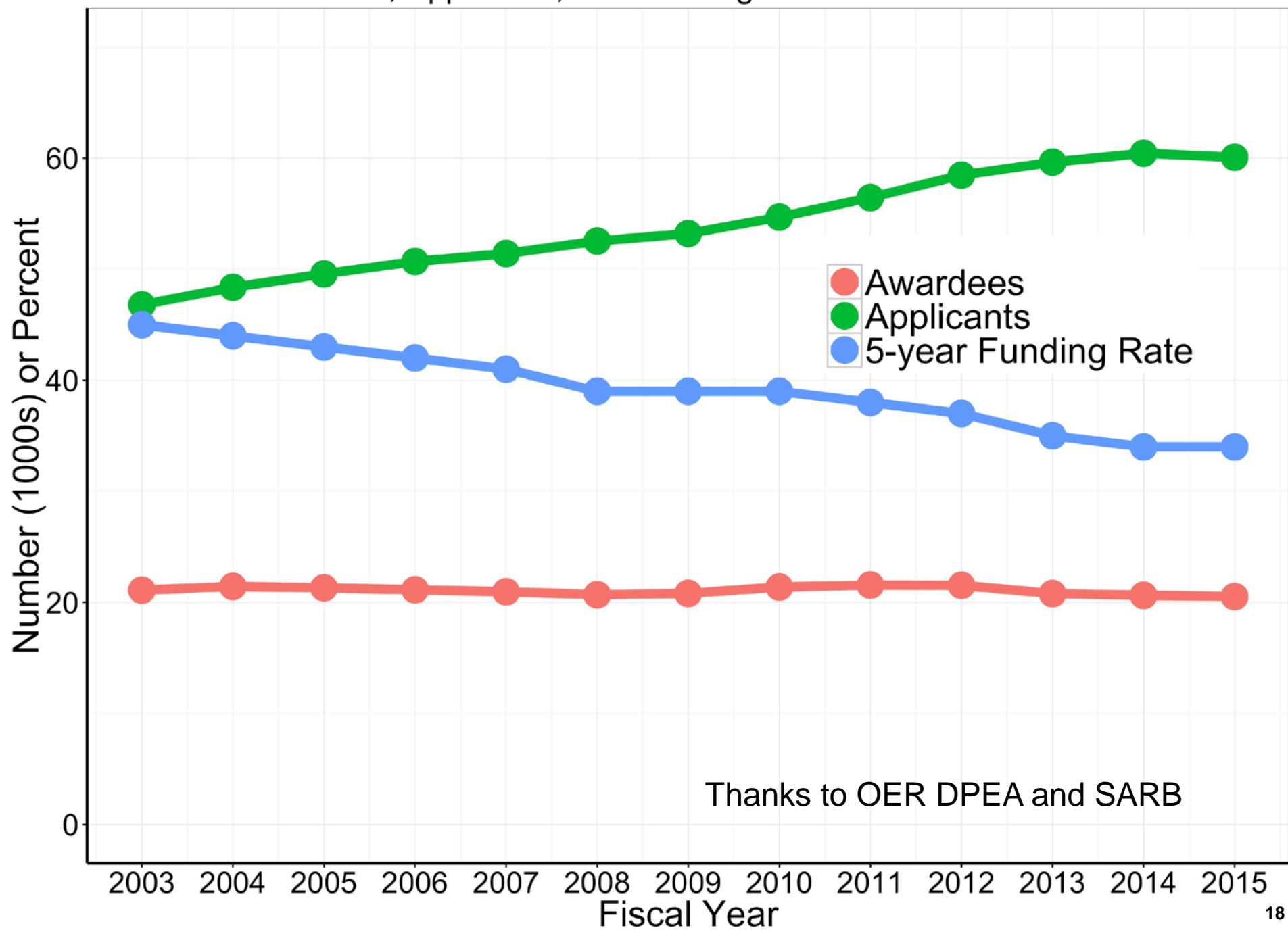
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015



Awardees, Applicants, and Funding Rates for all RPGs over Time



Awardees, Applicants, and Funding Rates for R01s over Time





PERSPECTIVE



CrossMark  
← click for updates

PERSPECTIVE

## Rescuing US biomedical research from its systemic flaws

**Bruce Alberts<sup>a</sup>, Marc W. Kirschner<sup>b</sup>, Shirley Tilghman<sup>c,1</sup>, and Harold Varmus<sup>d</sup>**

<sup>a</sup>Department of Biophysics and Biochemistry, University of California, San Francisco, CA 94158; <sup>b</sup>Department of Systems Biology, Harvard Medical School, Boston, MA 02115; <sup>c</sup>Department of Molecular Biology, Princeton University, Princeton, NJ 08540; and <sup>d</sup>National Cancer Institute, Bethesda, MD 20892

Edited by Inder M. Verma, The Salk Institute for Biological Studies, La Jolla, CA, and approved March 18, 2014 (received for review March 7, 2014)

The long-held but erroneous assumption of never-ending rapid growth in biomedical science has created an unsustainable hypercompetitive system that is discouraging even the most outstanding prospective students from entering our profession—and making it difficult for seasoned investigators to produce their best work. This is a recipe for long-term decline, and the problems cannot be solved with simplistic approaches. Instead, it is time to confront the dangers at hand and rethink some fundamental features of the US biomedical research ecosystem.

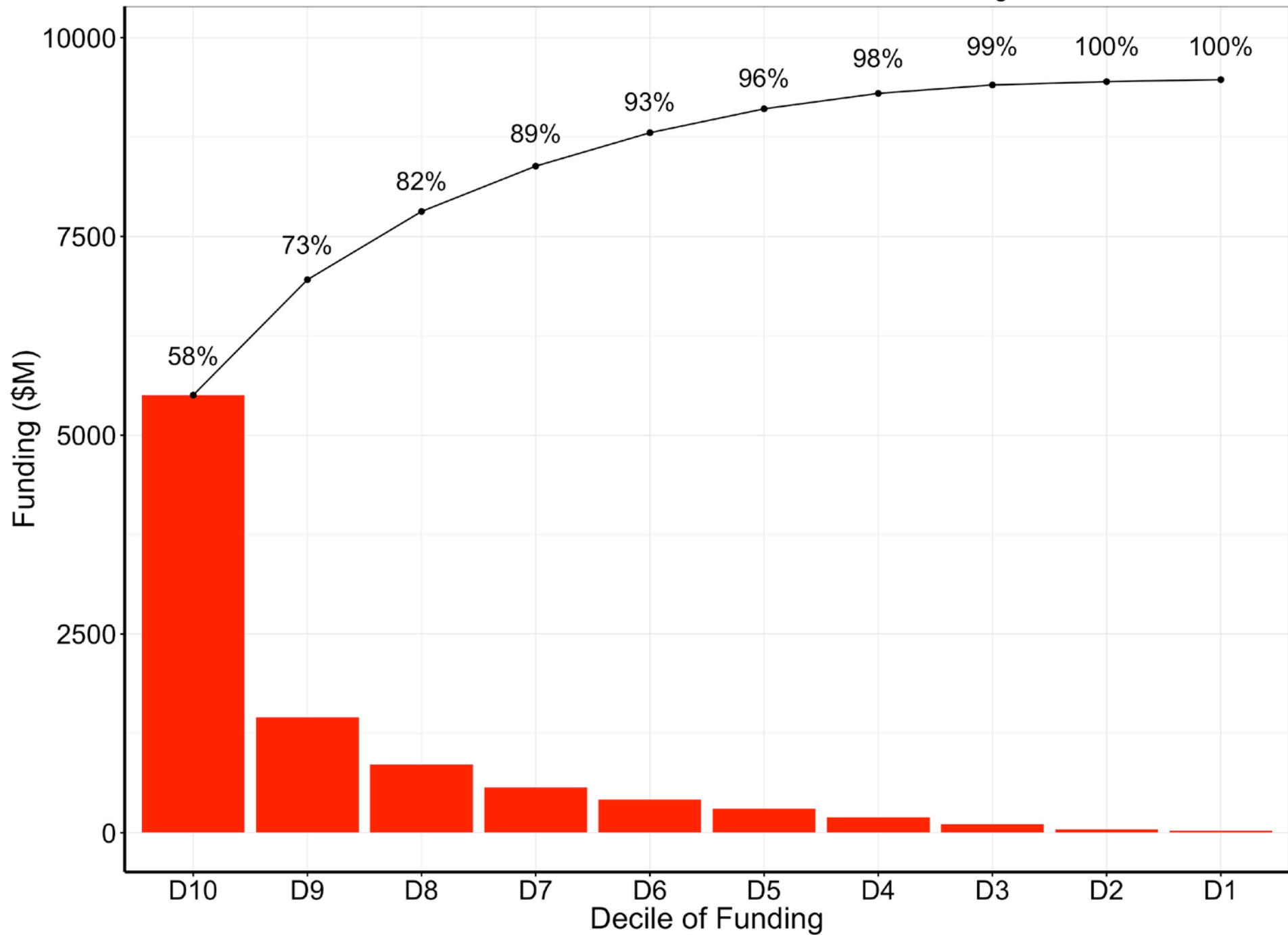
“... unsustainable hypercompetitive system ... a recipe for long-term decline ... rethink some fundamental features of the US biomedical research ecosystem...”

Alberts B et al. PNAS. 2014;111:5773-7



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Office of Extramural Research

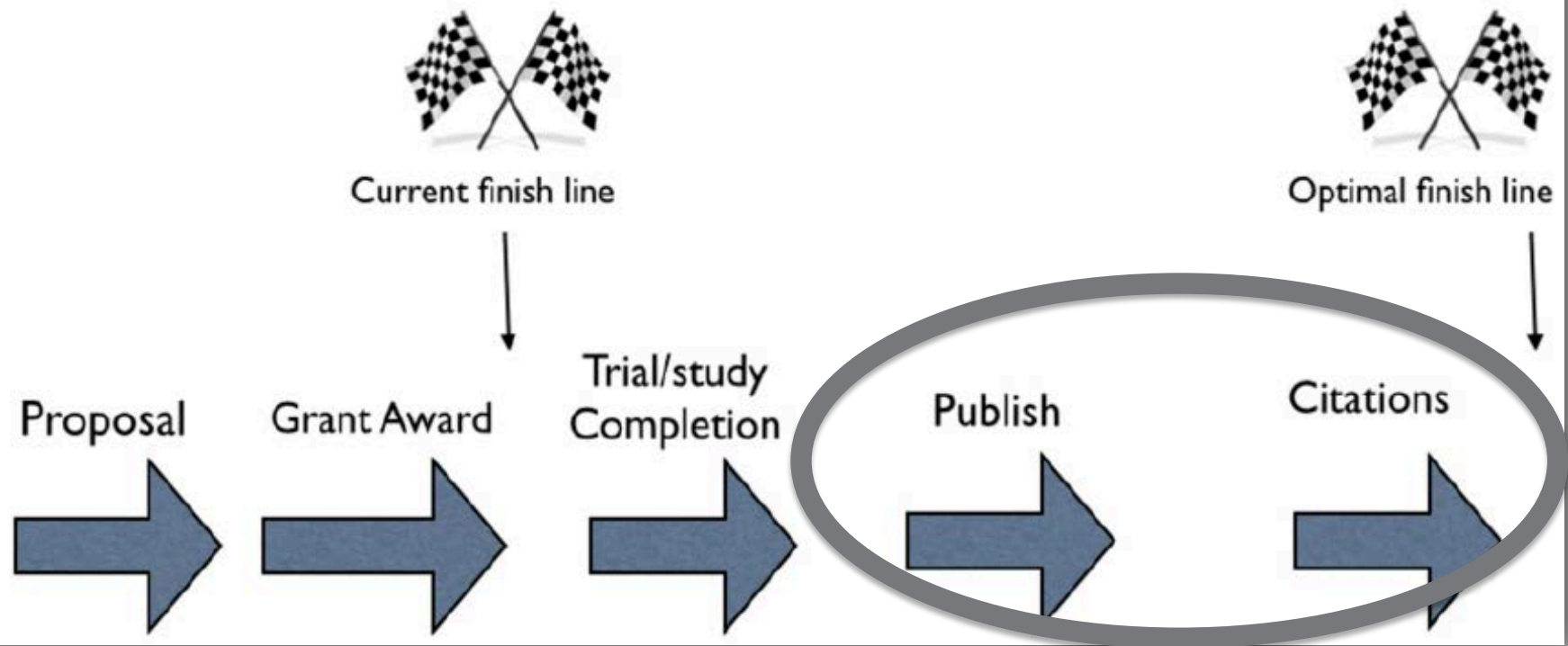
Pareto Plot: 10% of Scientists Get 58% of Funding





# Publication and Citations?

## A New Finish Line



# So How Do We Measure Research Impact?

## VIEWPOINT

## Assessing Value in Biomedical Research The PQRST of Appraisal and Reward

- P = productivity
  - Publish trial results
  - Highly-cited papers: **field-normalized**
- Q = quality
- R = replication
- S = sharing
- T = translation

# The Leiden Manifesto for research metrics

Use these ten principles to guide research evaluation, urge **Diana Hicks**,  
**Paul Wouters** and colleagues.

*science & society*  
*science & society*

## How good is research really?

Measuring the citation impact of publications with percentiles increases correct assessments and fair comparisons

*Lutz Bornmann & Werner Marx*

Hicks D, Wouters P et al. Nature 2015;520:429-31  
Bornmann L, Marx W. EMBO Reports 2013;14:226-30



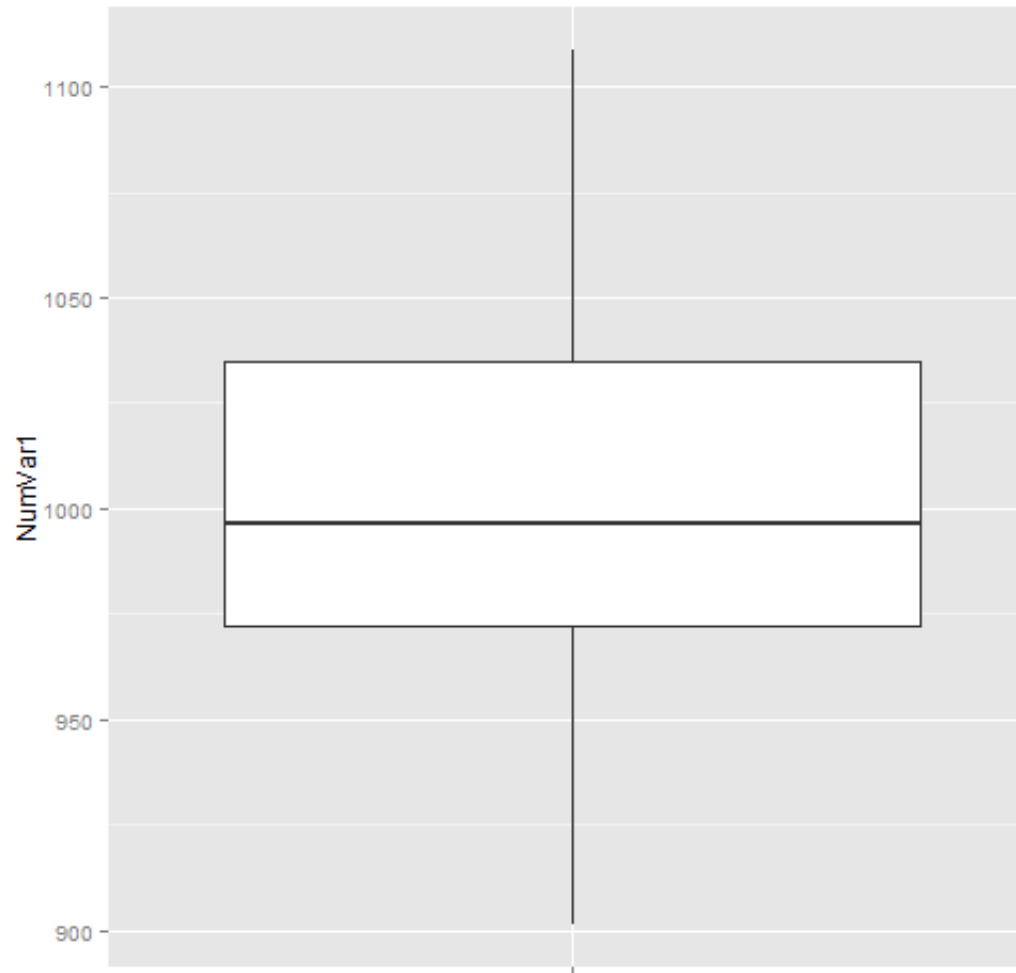
National Institutes of Health  
Office of Extramural Research

- NIH Type 1 RPG funded 1985 - 2012
- Data from IMPAC II, SPIRES
  - Grants = 135,315
  - Papers = 793,409
  - Scientists = 65,858
  - Organizations = 2549

- Data from Thomson Reuters (95% match)
- Each paper binned by:
  - Topic (empiric, one of 252)
  - Year of publication; type (research, review)
- Each paper percentiled (0-100%)
- Sum to calculate grant citation impact

Hicks D, Wouters P et al. Nature 2015;520:429-31  
Bornmann L, Marx W. EMBO Reports 2013;14:226-30

# Quick Review of Box Plots



75<sup>th</sup> percentile

Median

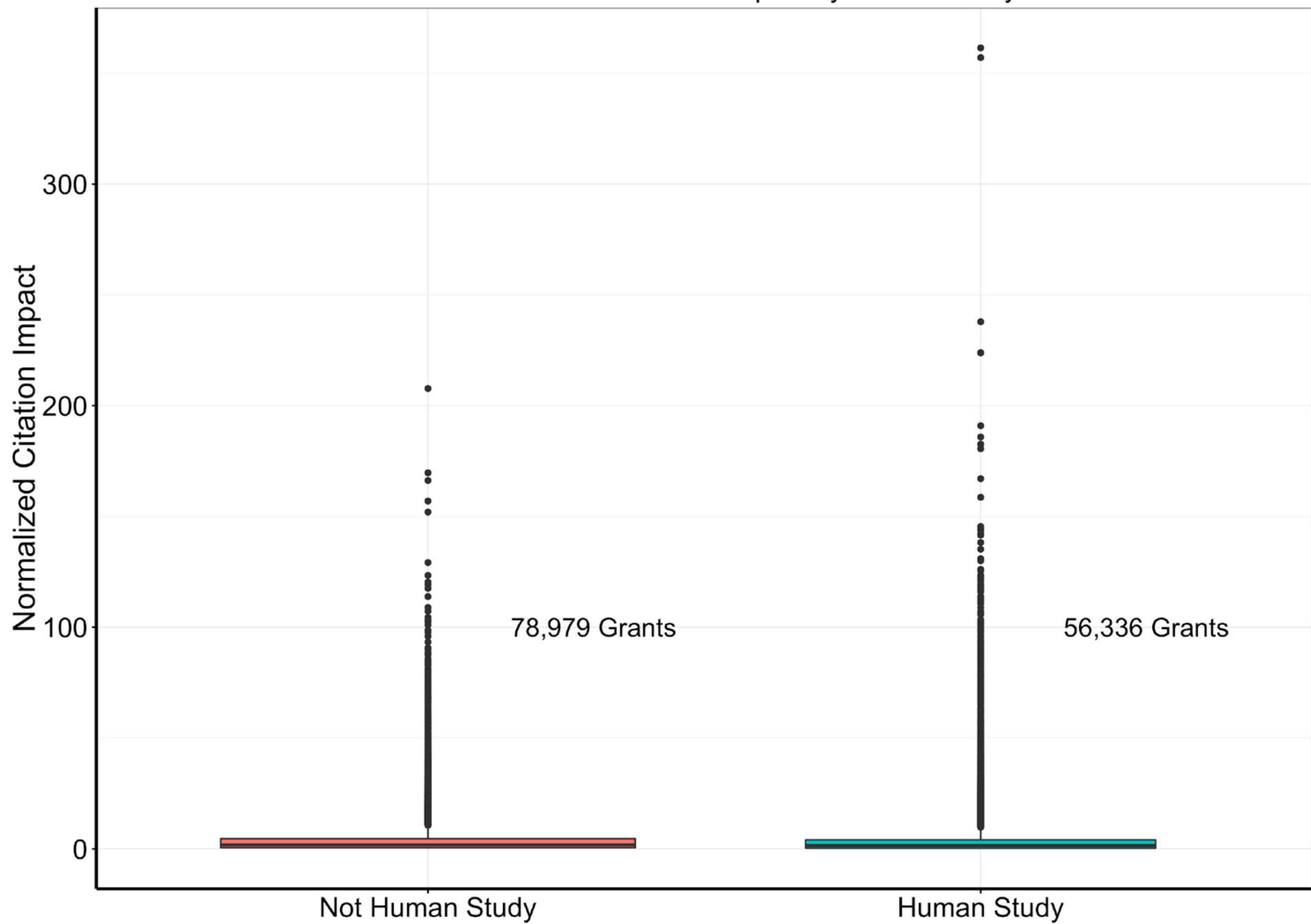
25<sup>th</sup> percentile

<http://patilv.com/img/2013-11-7-Replication-of-few-graphs-charts-in-base-R-ggplot2-and-rCharts-part-2-ggplot2/unnamed-chunk-34.png>

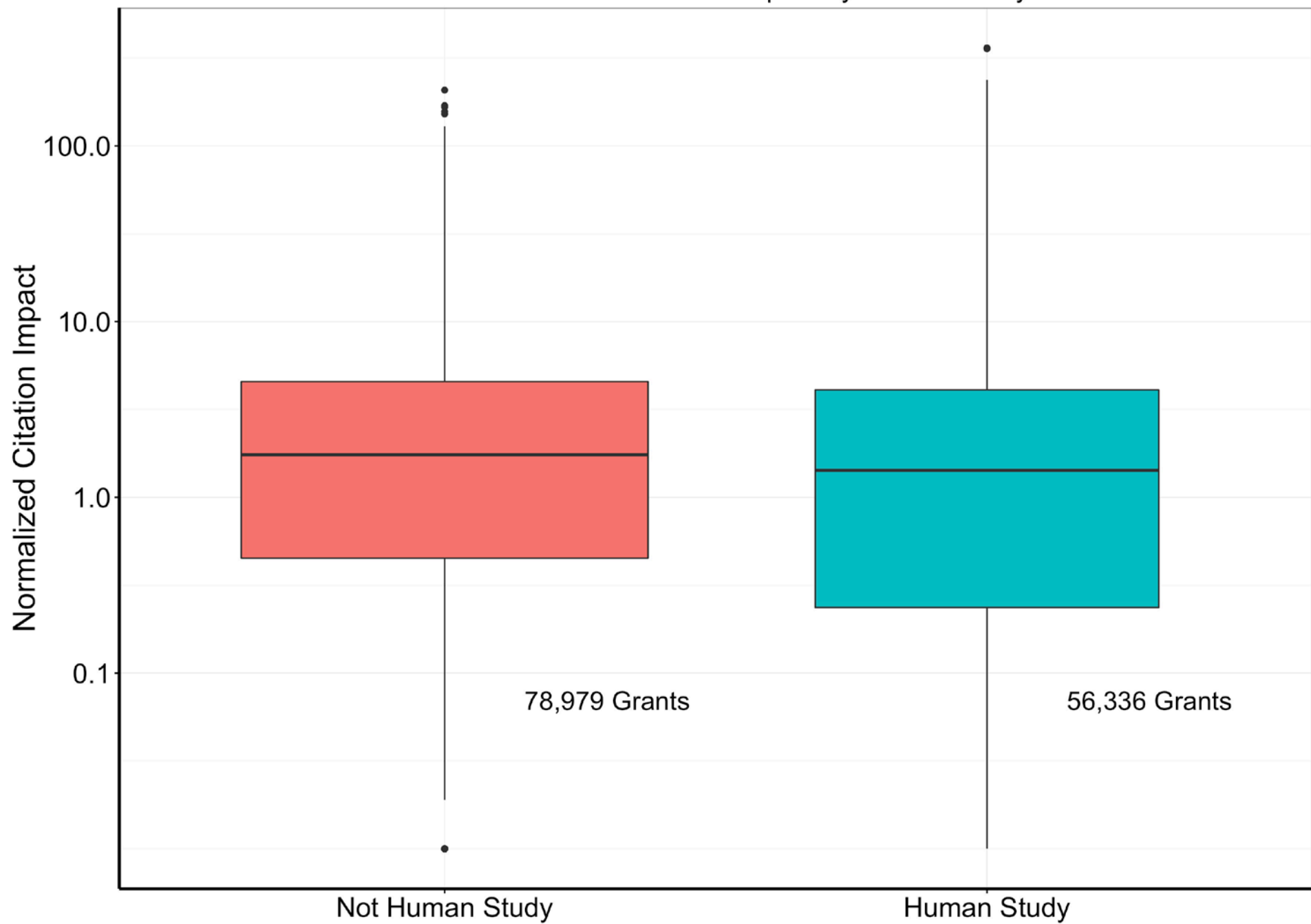




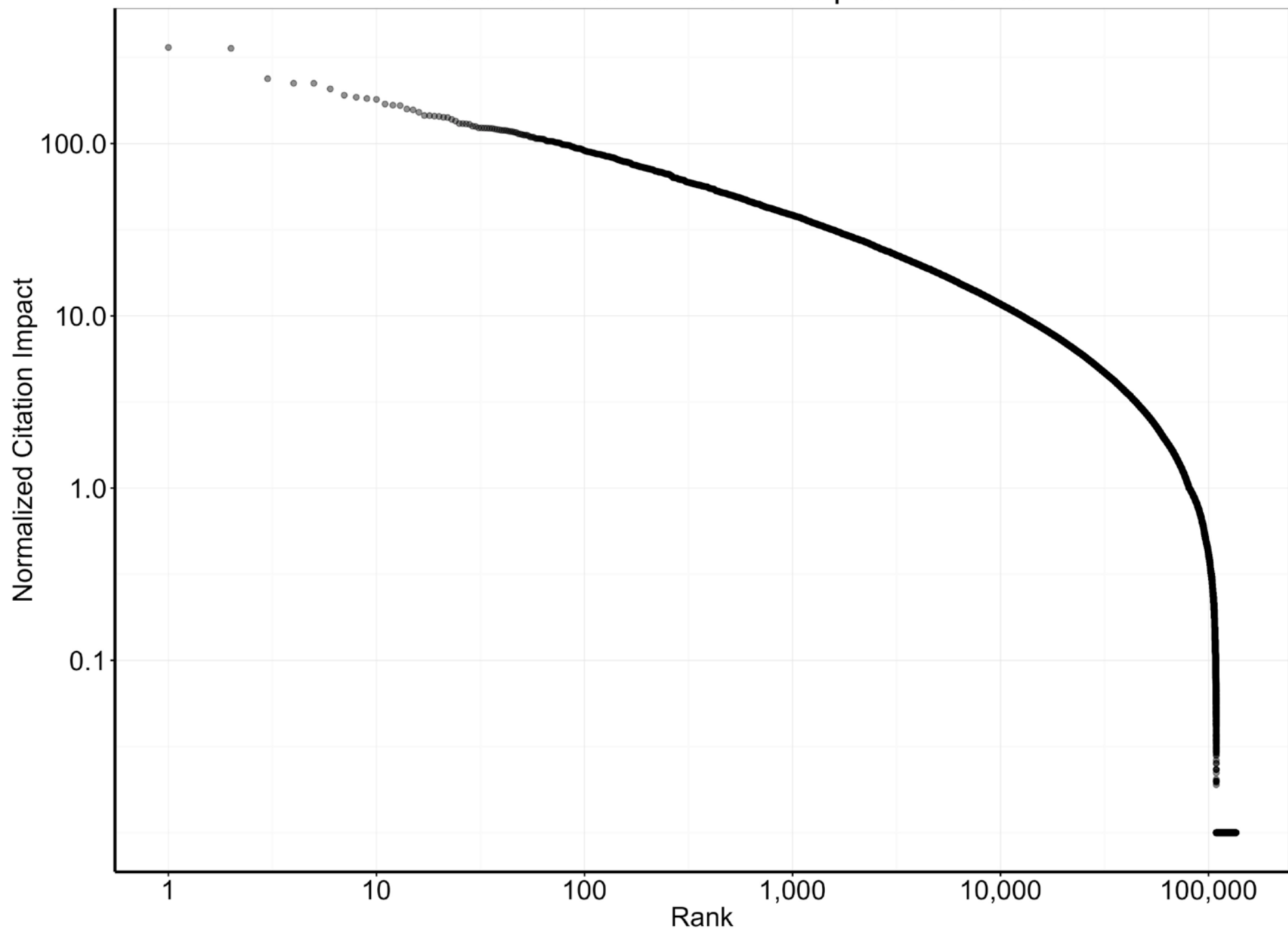
Box Plot NIH RPG Citation Impact by Human Study



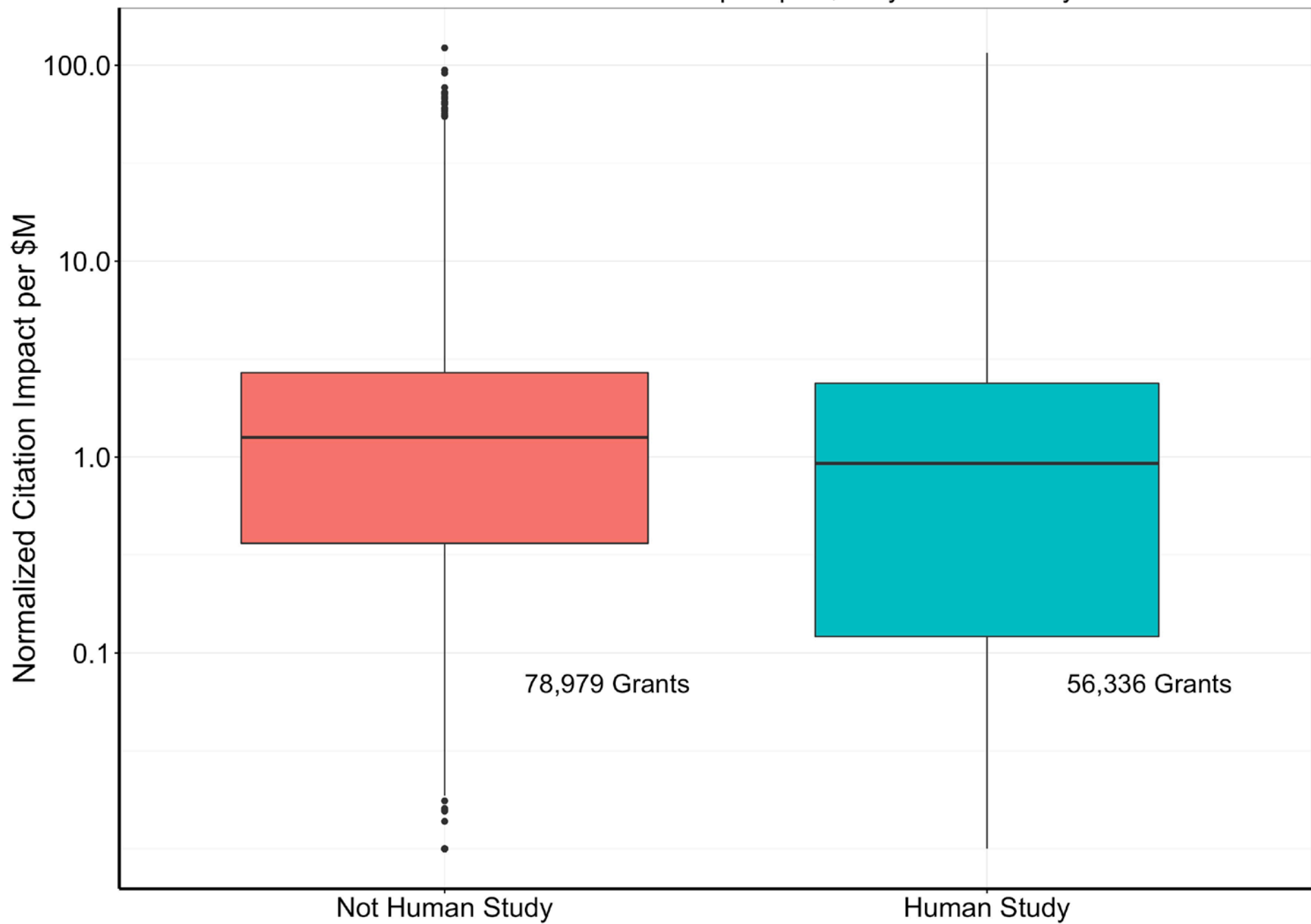
Box Plot NIH RPG Citation Impact by Human Study



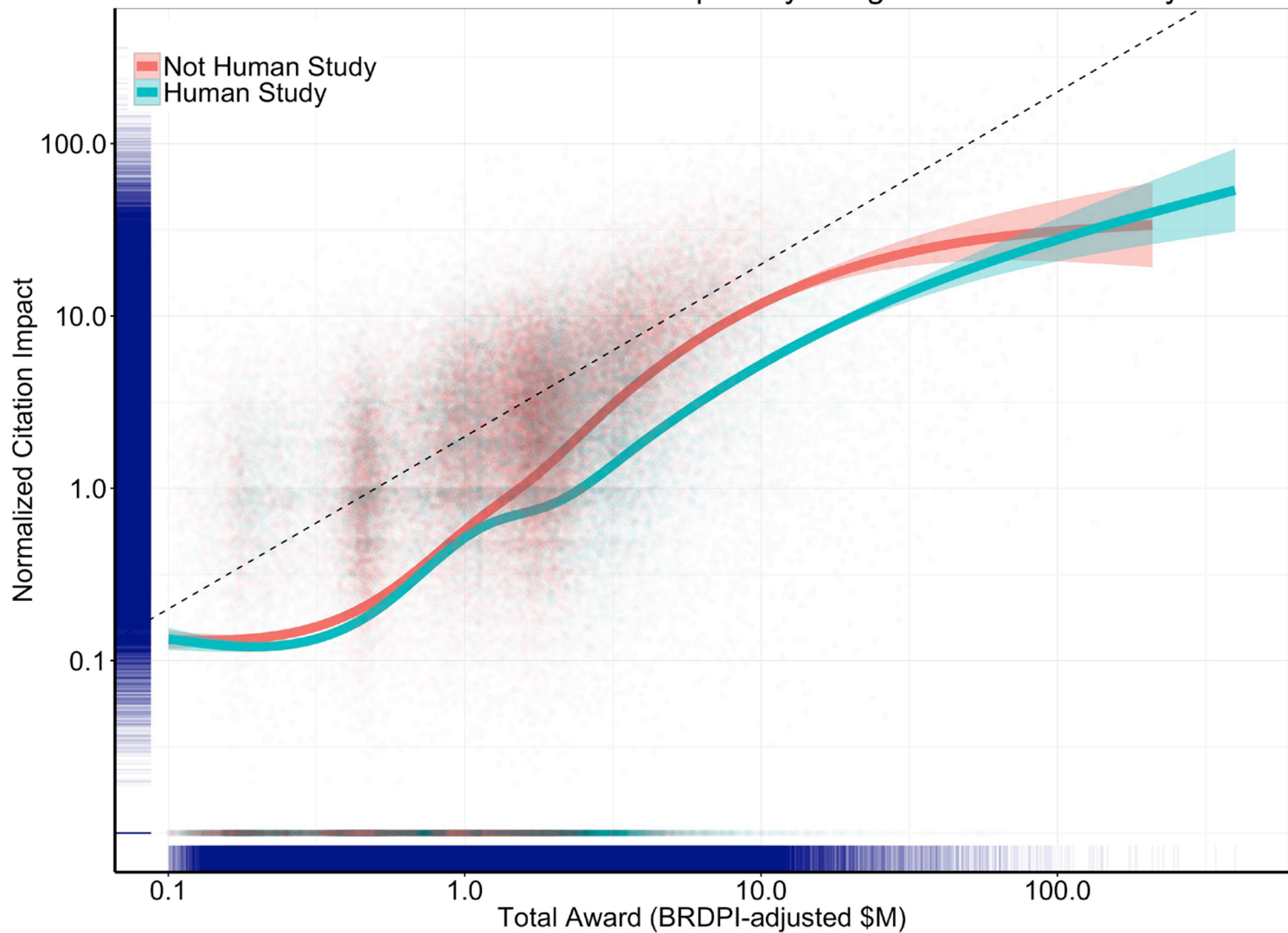
NIH RPG Normalized Citation Impact and Rank

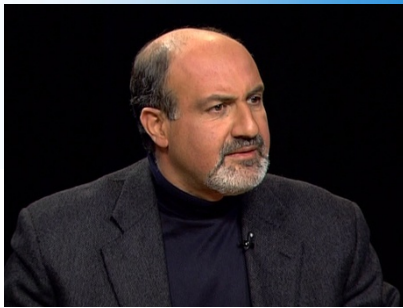


Box Plot NIH RPG Citation Impact per \$M by Human Study



NIH RPG Normalized Citation Impact by Budget and Human Study





## What the Power Law Means ...

“Payoffs from research follow a power law, with big, near-unlimited upside but limited downside. Since the winner will have an explosive payoff, the right approach requires *a certain style of blind funding ... [of] as large a number of projects as possible...*”

Nassim Nicholas Taleb

Taleb N 2012 Random House



## Power Laws in Economics: An Introduction

Xavier Gabaix



“Why do social scientists care? One implication of the [power] law is that there are **many more extreme events** than would occur if the distribution were Gaussian; for example, if the distribution were the result of a series of events of fixed probability, like flipping coins or rolling dice.”

## Maximizing Investigator's Research Award (R35)

R35 Outstanding Investigator Award

Reissue of RFA-GM-16-002

- NOT-OD-16-004 - NIH & AHRQ Announce Upcoming Changes to Policies, Instructions and Forms for 2016 Grant Applications (November 18, 2015)

## RFA-GM-17-002



# Programs, not Individual Projects

- Stability of funding
- Flexibility – “follow your nose”
- Distribution of funding
- ***Less time writing grant applications***
- Less time reviewing grant applications

<https://publications.nigms.nih.gov/presentations/MIRA-Reissue-RFA-GM-17-002-Webinar-Revised.pdf>

## NHLBI Emerging Investigator Award (EIA) (R35)

R35 Outstanding Investigator Award

New

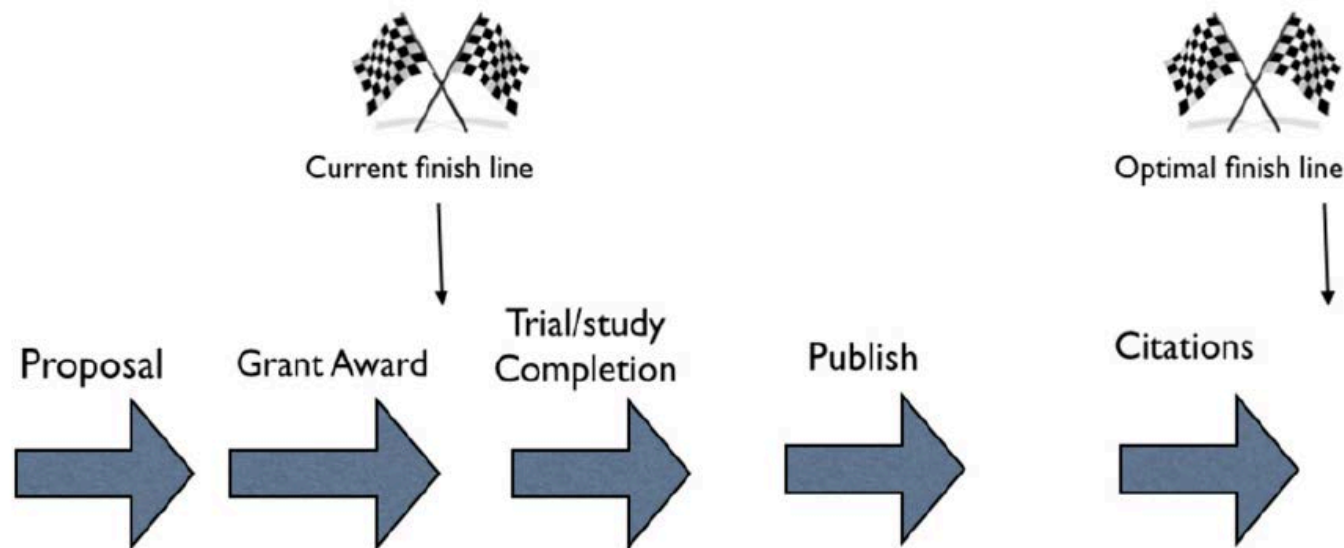
- [March 22, 2016](#) - Notice of Correction to Funding Opportunity Description for RFA-HL-16-025. See Notice [NOT-HL-16-302](#).
- [January 6, 2016](#) - Notice of Correction to Award Information for RFA-HL-16-025. See Notice [NOT-HL-15-296](#).
- [December 16, 2015](#) - Notice of Availability of Frequently Asked Questions and Answers for RFA-HL-16-025. See Notice [NOT-HL-15-289](#).
- [NOT-OD-16-004](#) - NIH & AHRQ Announce Upcoming Changes to Policies, Instructions and Forms for 2016 Grant Applications (November 18, 2015)

## RFA-HL-16-025



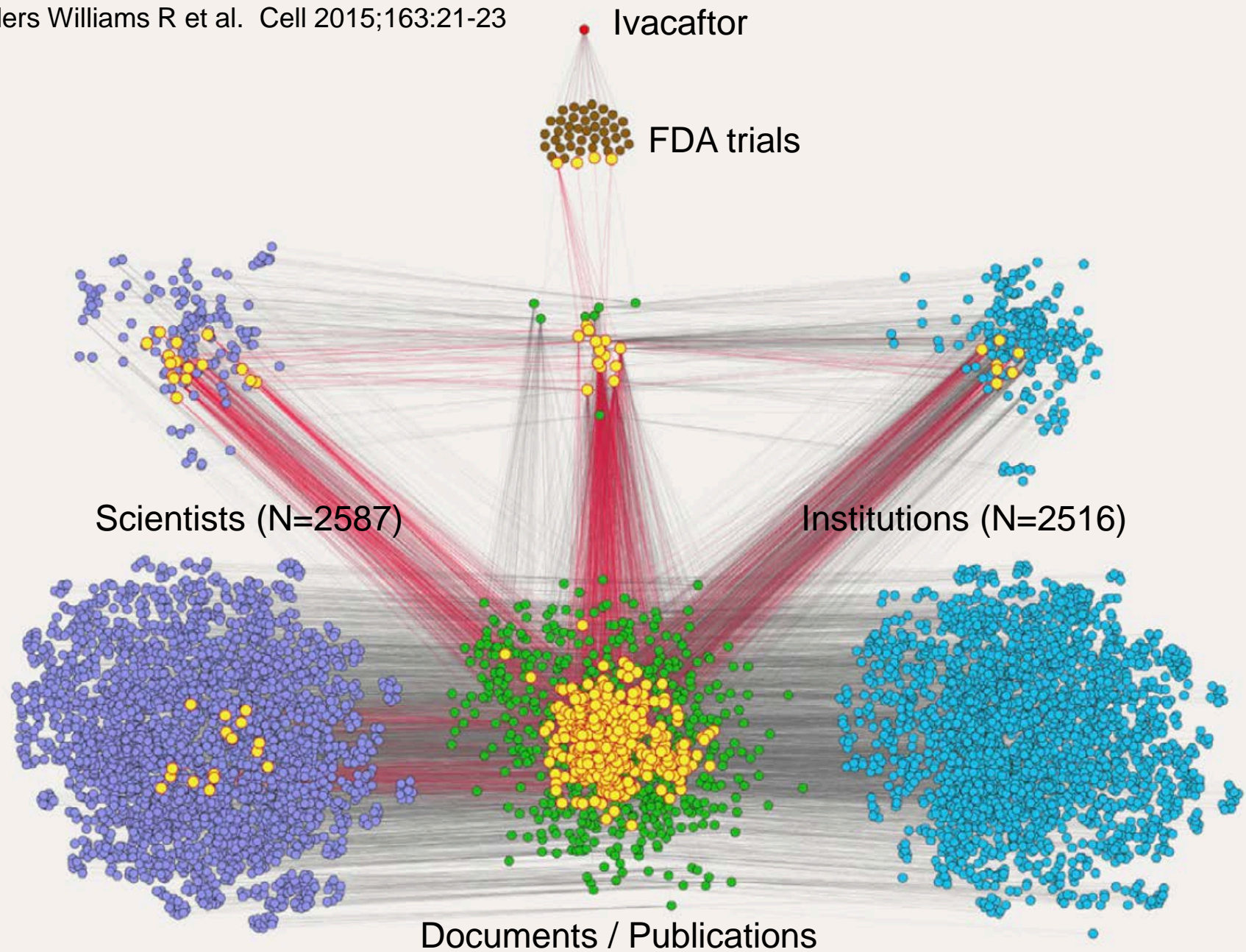
# Another Finish Line?

## A New Finish Line



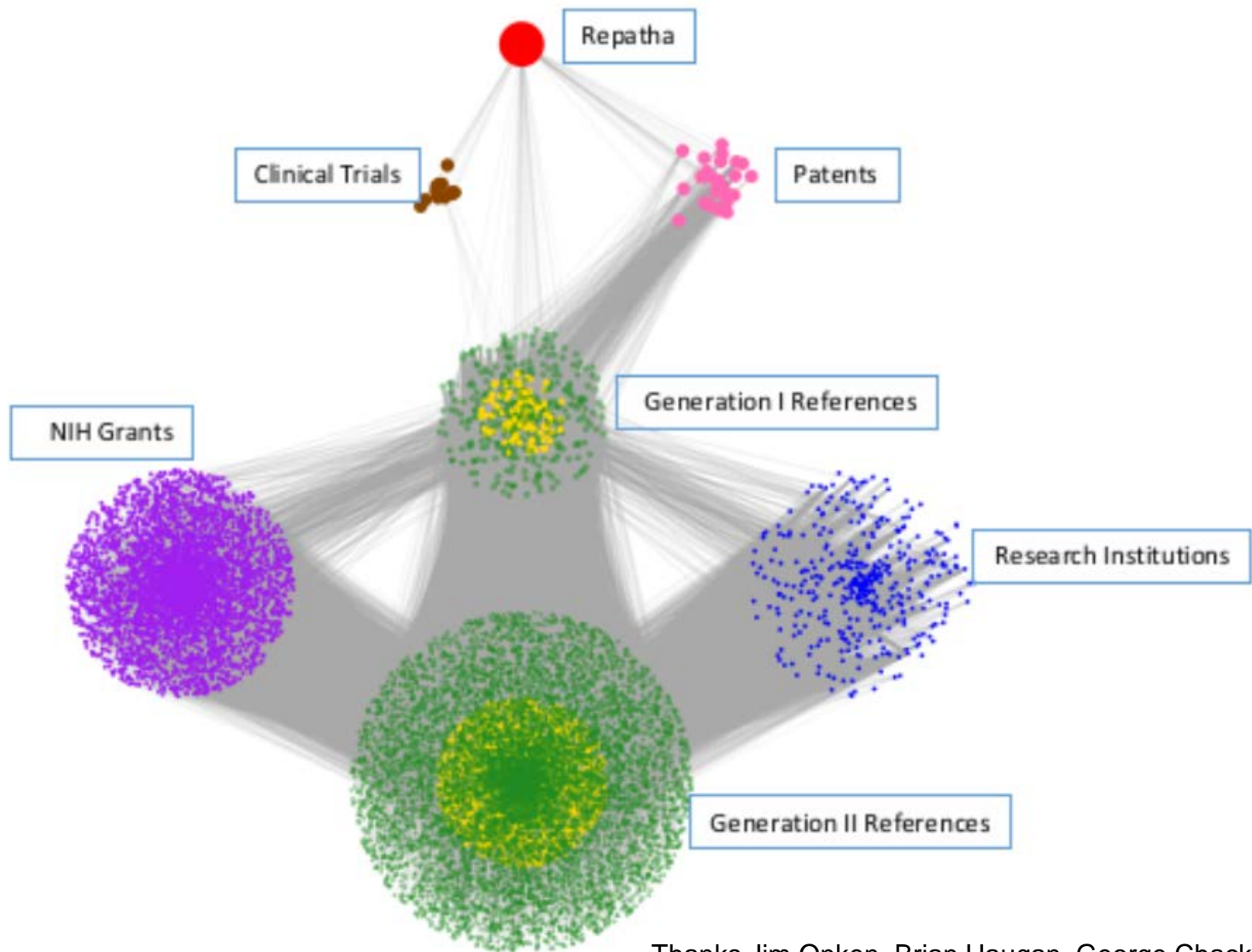
**B**

Sanders Williams R et al. Cell 2015;163:21-23





# Telling a Story with Big Data



Thanks Jim Onken, Brian Haugan, George Chacko, Shixin Jiang, Samet Keserci, Alex Pico, and Lindsay Wan



National Institutes of Health  
Office of Extramural Research

## NIH-Wide Strategic Plan Framework

### Overview

- Mission of NIH
- Unique moment of opportunity in biomedical research
- Current NIH-supported research landscape
- Constraints confronting the community in the face of lost purchasing power

### Advance Opportunities in Biomedical Research

#### Fundamental Science

- Foundation for progress
- Consequences often unpredictable
- Technology leaps catalyze advances
- Data science increases impact/efficiency

#### Health Promotion/Disease Prevention

- Importance of studying healthy individuals
- Advances in early diagnosis/detection
- Evidence-based reduction of health disparities

#### Treatments/Cures

- Opportunities based on molecular knowledge
- Breakdown of traditional disease boundaries
- Breakthroughs need partnerships, often come from unexpected directions
- Advances in clinical methods stimulate progress

### Set Priorities

- Incorporate disease burden as important, but not sole factor
- Foster scientific opportunity; remain nimble
- Advance opportunities presented by rare diseases
- Consider value of permanently eradicating a pandemic risk

### Enhance Stewardship

- Recruit/retain outstanding research workforce
- Enhance workforce diversity
- Encourage innovation
- Optimize approaches to inform funding decisions
- Enhance impact through partnerships
- Ensure rigor and reproducibility
- Reduce administrative burden

### Excel as a Federal Science Agency by Managing for Results

- Science of science
- Outputs, outcomes
- Workforce analyses
- Review peer review
- Rigor, reproducibility
- Administrative burden
- Risk management





# Others are Singing This Tune ...



## Turn the scientific method on ourselves

How can we know whether funding models for research work? By relentlessly testing them using randomized controlled trials, says **Pierre Azoulay**.

“It is a scandal that billions of dollars are spent on research without knowing the best way to distribute that money.”

John Ioannidis

Azoulay P. Nature 2012;484:31-32

Ioannidis J. Nature 2011; 477:529-31



National Institutes of Health  
Office of Extramural Research

# Looking Forward to Open Dialogue ...

### Open Mike

*Helping connect you with the NIH perspective, and helping connect us with yours*

## Updates on Addressing Rigor in Your NIH Applications

Posted on **January 11, 2016** by **Mike Lauer**

As NIH moves ahead with implementing measures to enhance rigor, transparency and reproducibility in NIH-supported research, I'd like to give a brief update on these efforts, and highlight some important timeline changes for implementation in applications for institutional training grants (T), institutional career development awards (K12), and individual fellowships (F). .... [Continue reading →](#)



Dr. Michael Lauer is NIH's Deputy Director for Extramural Research, serving as the principal scientific leader and advisor to the NIH Director on the NIH extramural research program.