THE OHIO STATE UNIVERSITY

Thoughts on Tracking Grantee Successes

Bruce A. Weinberg

October 18, 2023

I want to do 3 things today:

1. Introduce you to the science of science
   - A community studying impact of research investments

2. Show things that can / have been done
   - Particular emphasis on identifying and tracking people

3. Make suggestions for the future
   - I hope this will be the beginning of a fruitful dialogue

Science of Science

Science of Science

- Study the production, impact, and value of science (broadly construed)
- One line of work studies the impact of funding

- The economics of science emphasizes causality
- “Regression discontinuities” are a popular design

- Data and program variation are important

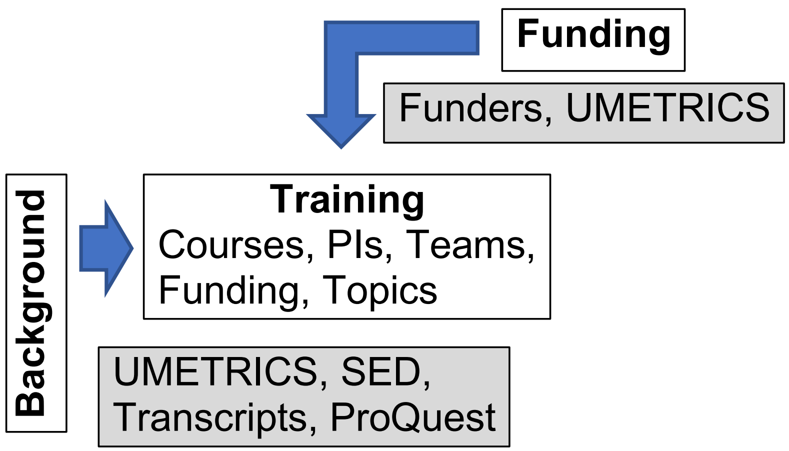
Things one can track

- Publications, patents, citations,…
- Fairly quick but distant from ultimate outcomes

- Health is hard to link back to investments
- It is somewhat measurable (QALYs, claims, EHR)
- But it is tricky to track ideas from lab to bedside
- We’ve done some work and advances may help (a bit)

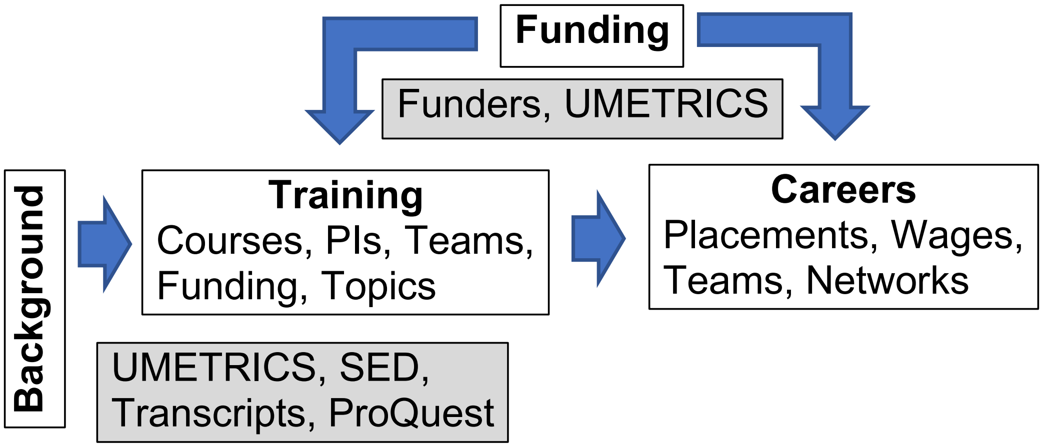
- People, especially trainees
- I think of as a key (and traceable) outcome

Our Approach



The Research Career in Data

Collaborators include: Wan-Ying Chang (NSF), Nate Goldschlag (Census), Ron Jarmin (Census); Julia Lane (NYU), Jason Owen-Smith (Michigan), Neil Smalhesier (UIC), Joe Staudt (Census), Vetle Torvik (UIUC), Nik Zolas (Census)



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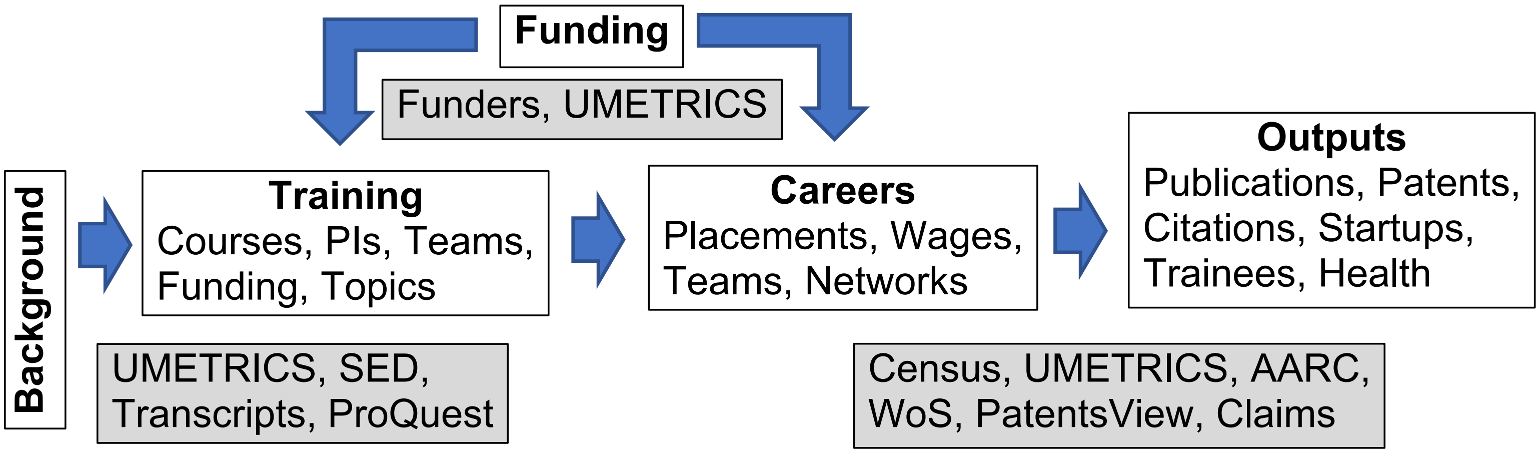

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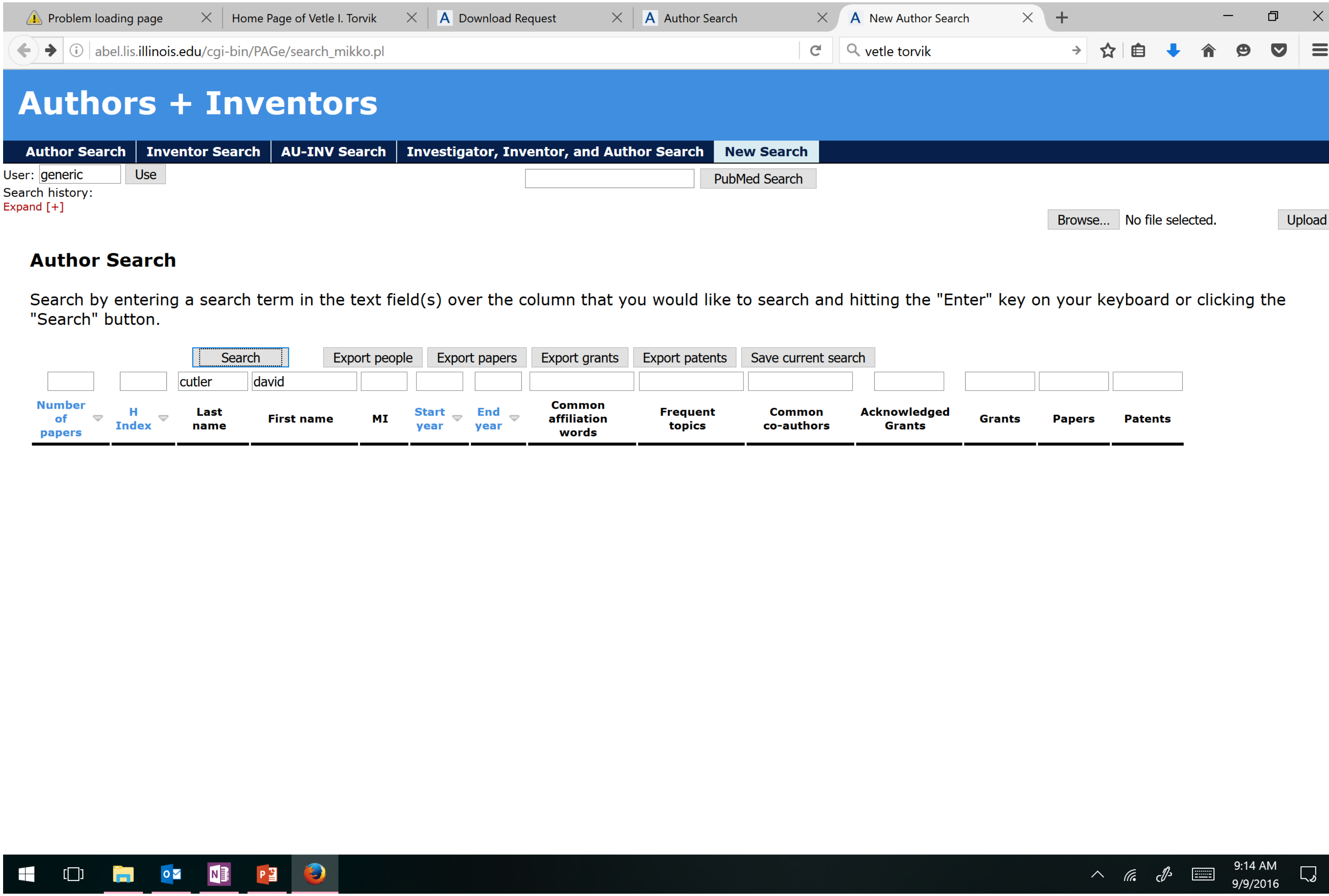
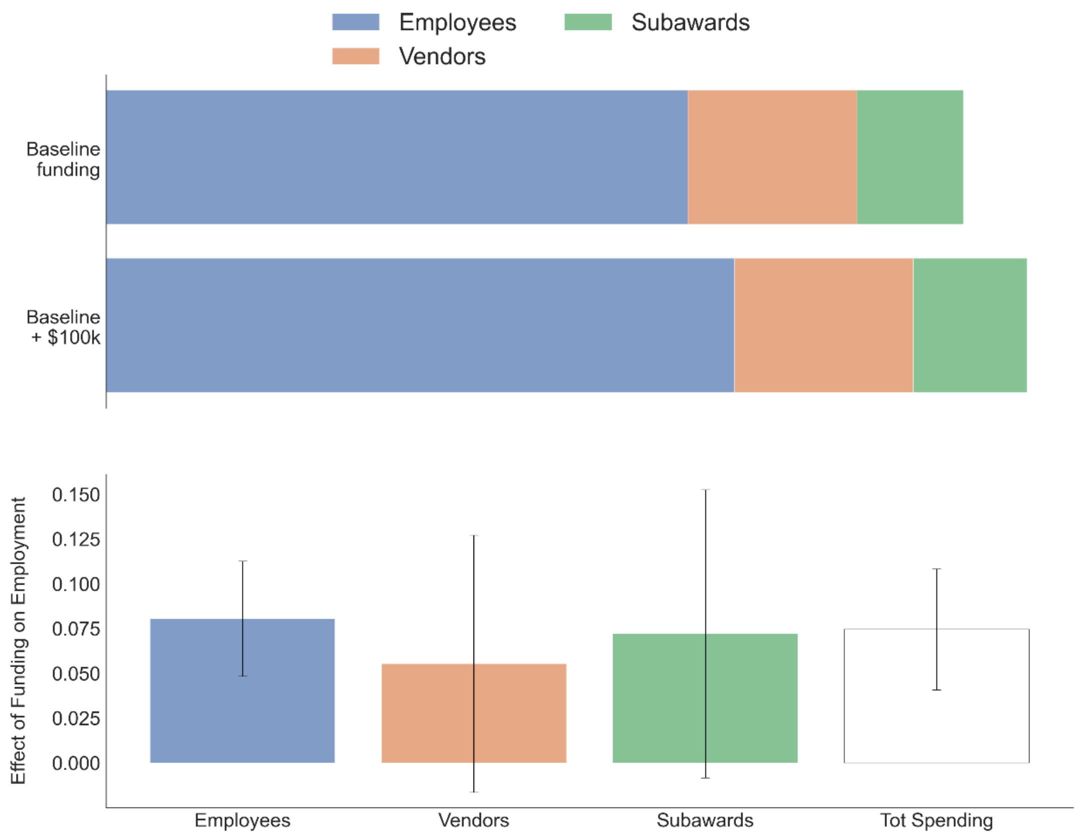


Funding supports… People



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Weinberg et. al., *Science*, 2014

POLICYFORUM

RESEARCH FUNDING

Science Funding and Short-Term Economic Activity

Expenditures from grant funds support many different types of workers and vendors across the nation.

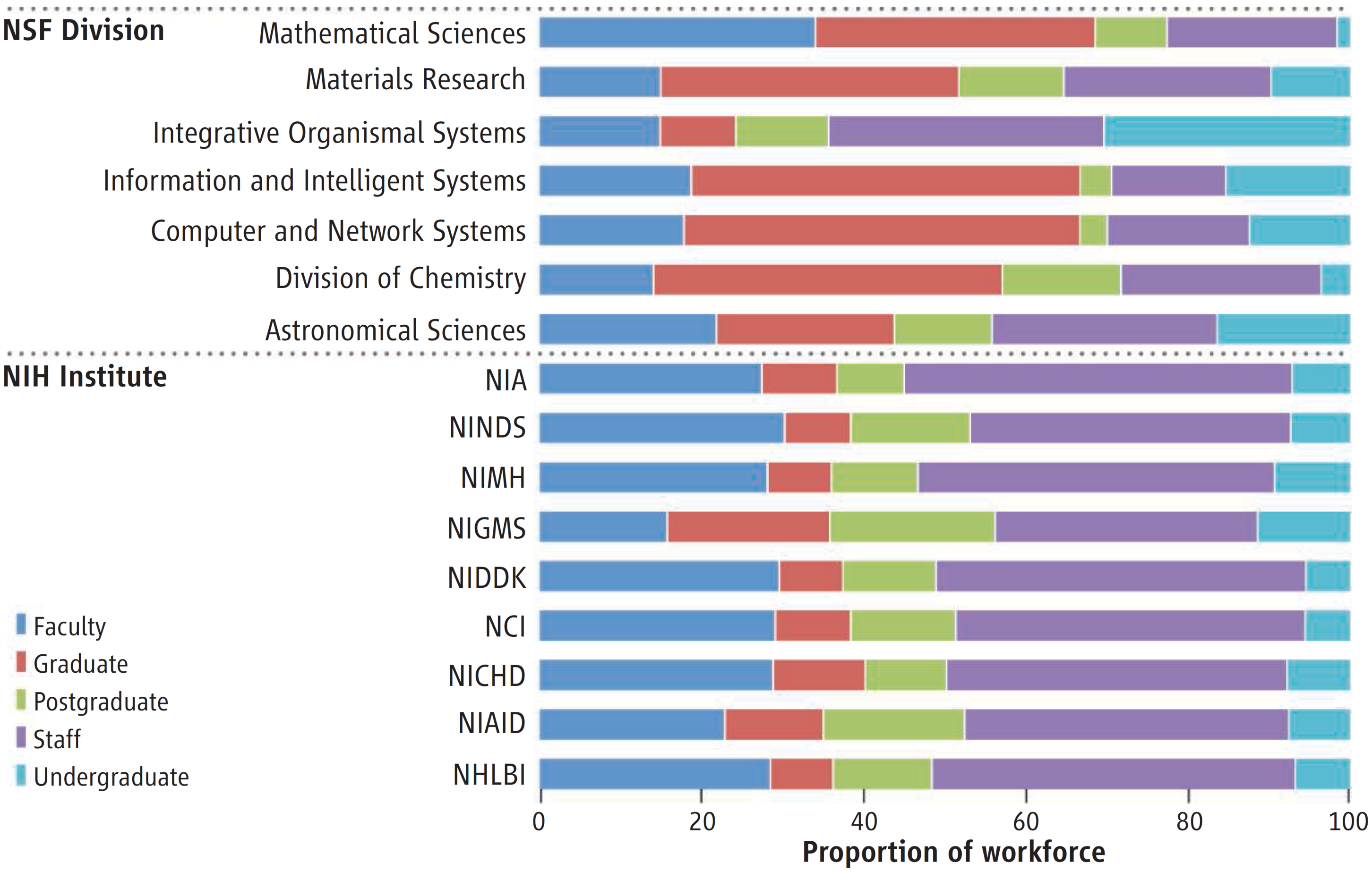
Bruce A. Weinberg,[1,2,3] Jason Owen-Smith,[4] Rebecca F. Rosen,[5] Lou Schwarz,[6] Barbara McFadden Allen,[7] Roy E. Weiss,[8] Julia Lane[5,9,10,11]*

There is considerable interest among policy-makers in documenting short-term effects of science funding. A multiyear scientific journey that leads to long-term fruits of research, such as a moon landing, is more tangible if there is visible nearer-term activity, such as the presence of astronauts. Yet systematic data on such activities have not heretofore existed. The only source of information for describing the production of most science is surveys that have been called "a rough estimate, frequently based on unexamined assumptions that originated

automated approaches to do so (*2*). The first tranche of rich data are drawn directly from university personnel and financial administrative records that track actual expenditures of all active federal projects. These data provide project-level information about the occupations of the part-time and full-time workforce paid on each funded grant and about the purchases made from vendors who supply scientific researchers. Neither of these types of information have reliably been available before (*3*, *4*).

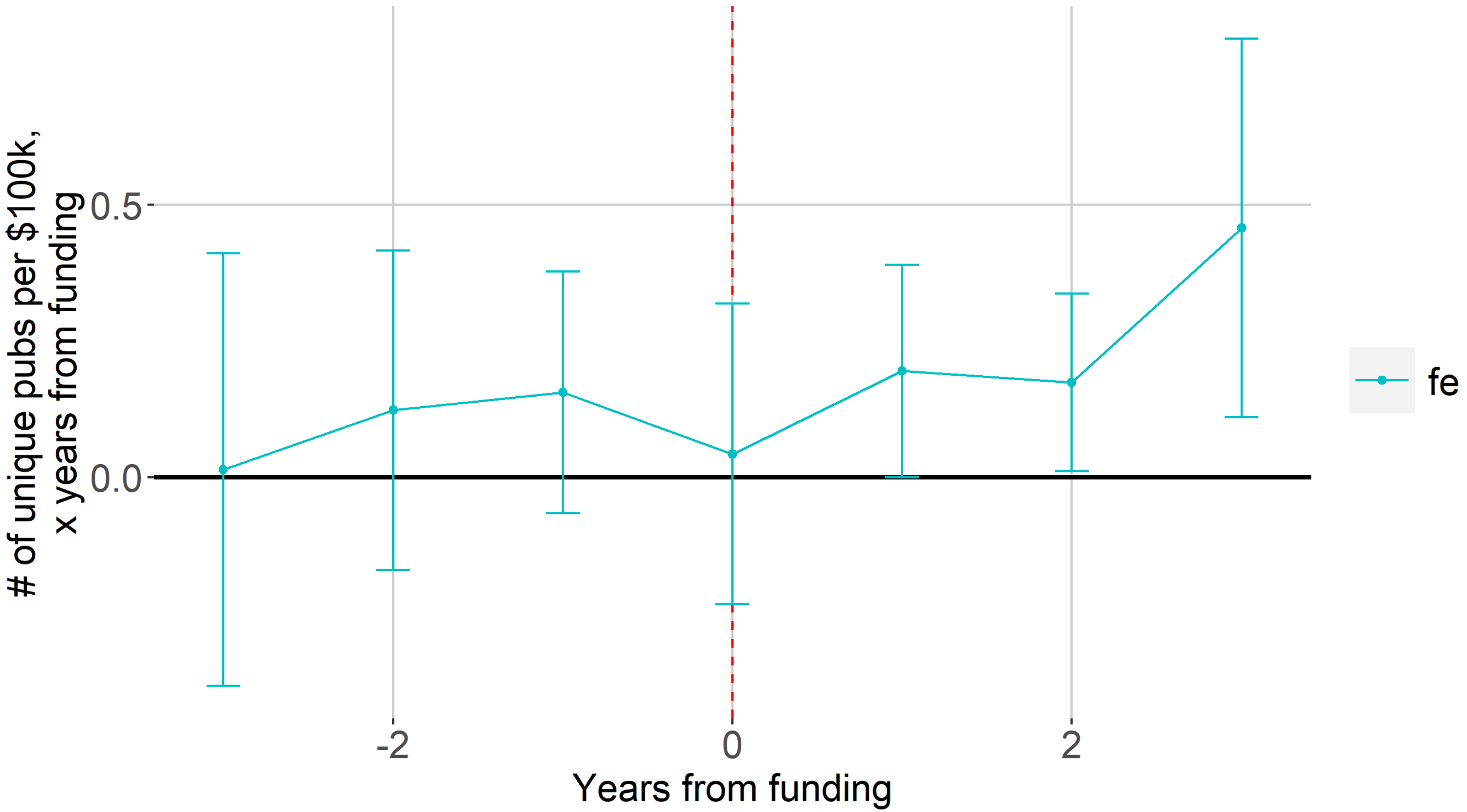
The results reported in this paper represent

aggregate, the 15 institutions that make up the CIC receive 8 to 10% of all federal research dollars. The majority of these institutions are large, Midwestern public universities. Hence, they are not representative of all recipients of federal funds. However, it is unlikely that the type of science that is conducted with those funds is markedly different from that conducted at many other major research universities, and they provide a window into a large portion of federal research activity in the era of tightening federal budgets. Moreover, the 2012 data we analyzed reflect expenditures

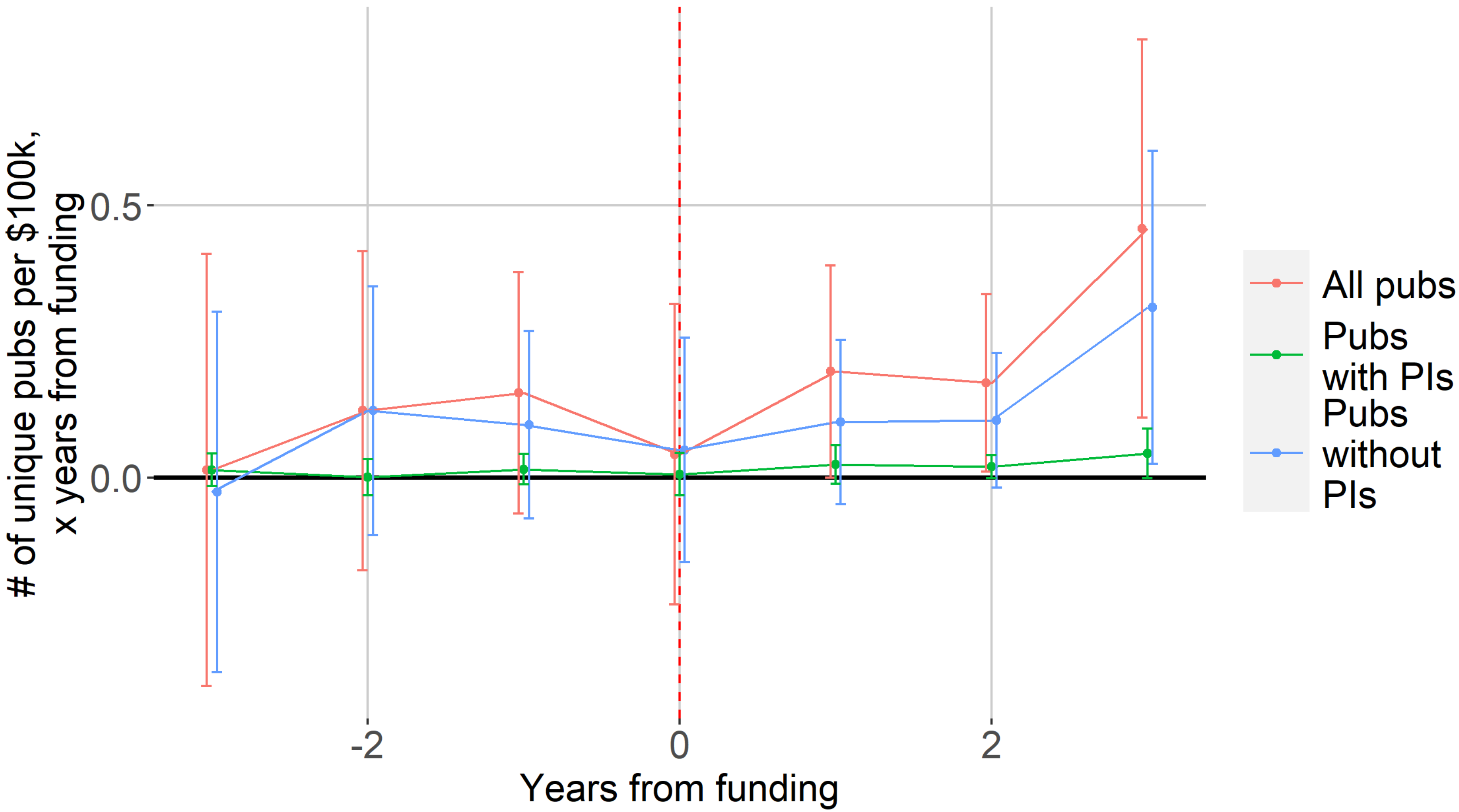


Differences in workforce composition in projects funded by NSF divisions and NIH institutes. NIA, National Institute on Aging; NINDS, National Institute of Neurological Disorders and Stroke; NIMH, National Institute of Mental Health; NIDDK, National Institute of Diabetes and Digestive and Kidney Diseases; NICHD, Eunice Kennedy Shriver National Institute of Child Health and Human Development; NIAID, National Institute of Allergy and Infectious Diseases; NHLBI, National Heart, Lung, and Blood Institute. (See SM.)

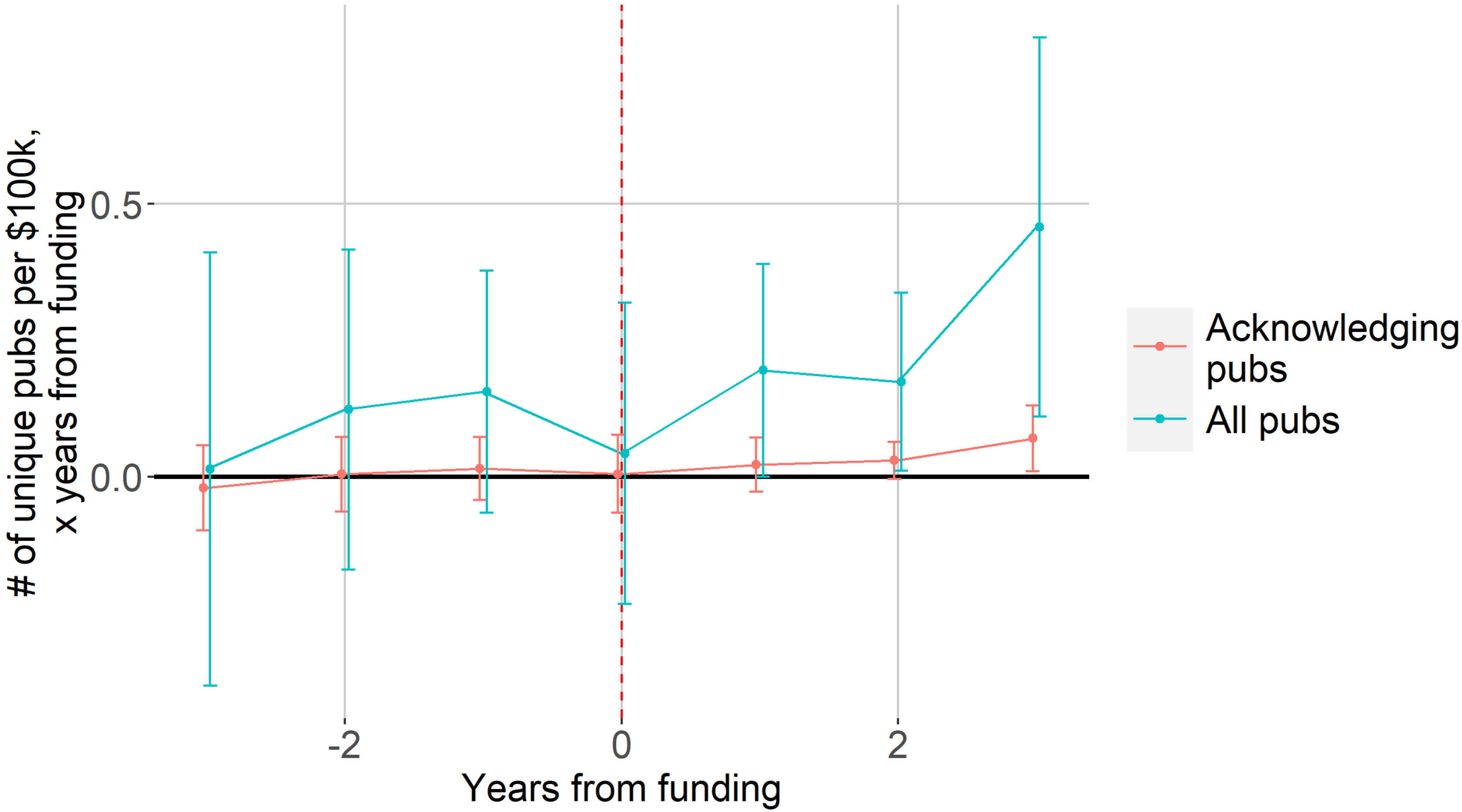
The Effects of Funding on Publications



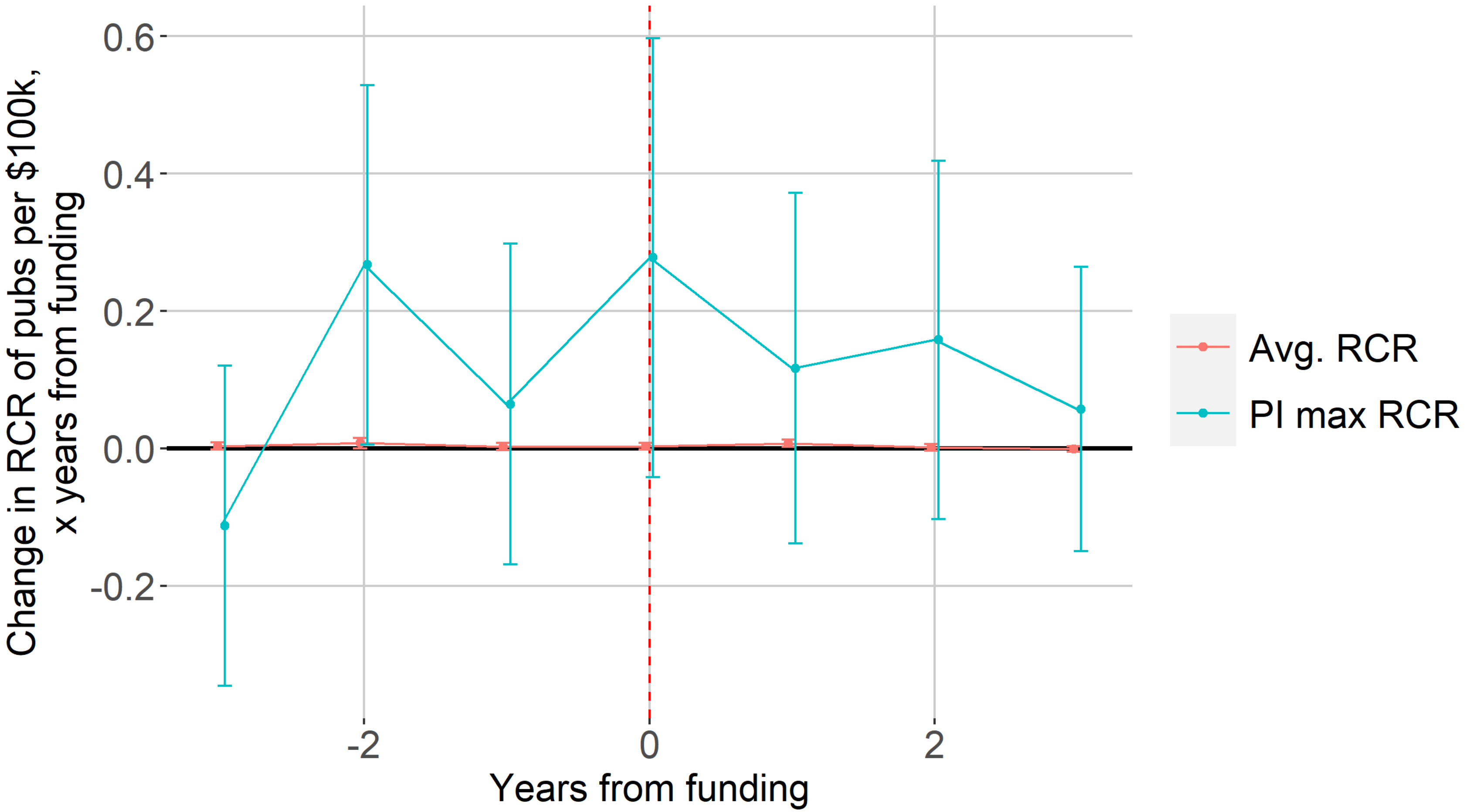
The Effects Operate through People other than the PI



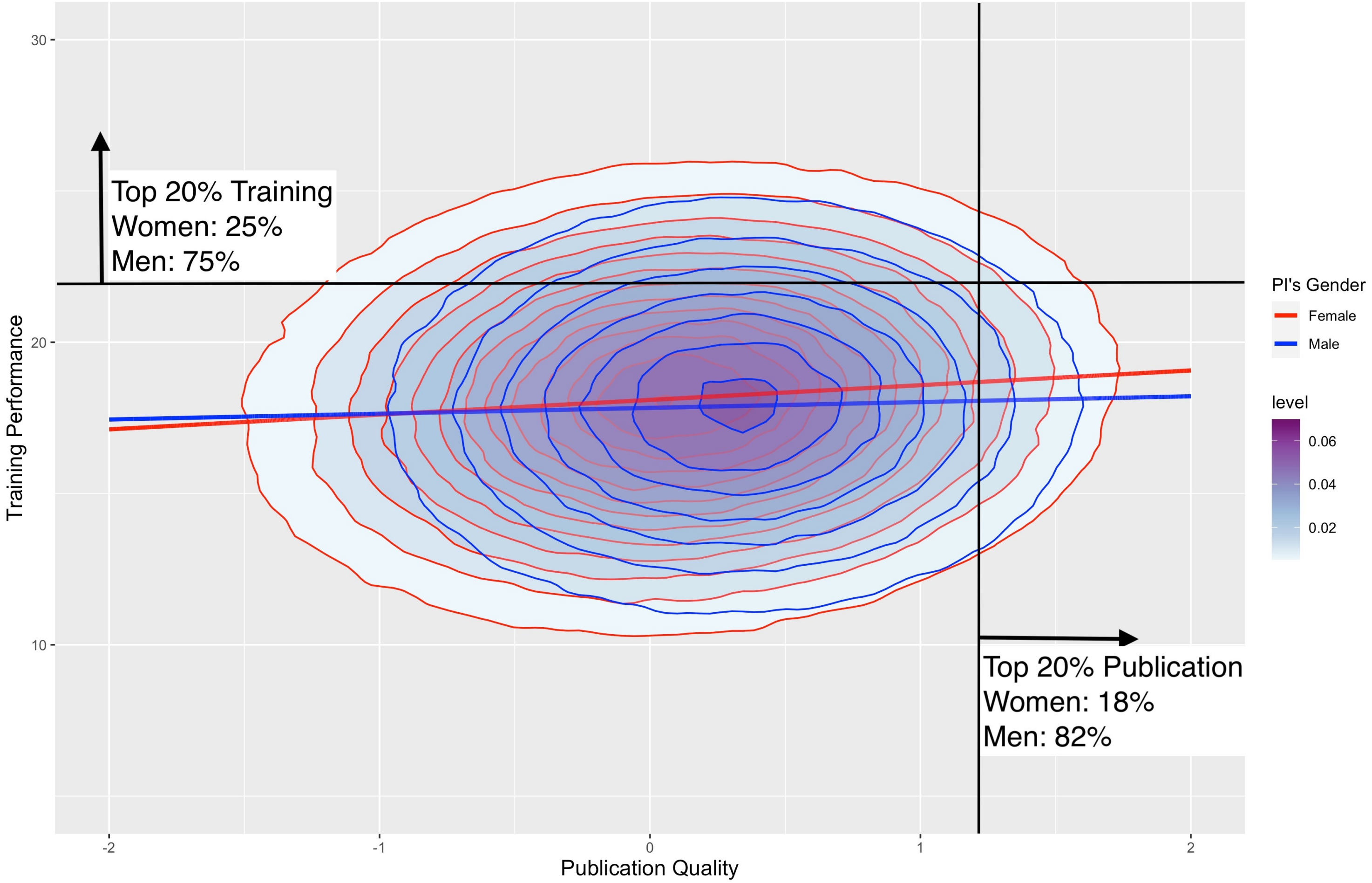
The Effects on Publications are Distinct from the Focal Project



Funding does not Reduce Quality



Mind the Gap (between training and research outcomes)



Identifying Important, Novel Ideas

Measures of Impact / Utilization of Work	
High Impact	Number of citations
Broad impact	Diversity of fields citing: One minus Herfindahl index of forward citations using MeSH (level 4) as field indicator
Measures of the Quality of the Research, May particularly depend on 1st Authors	
Builds on new ideas	Number of important new concepts utilized: number of concepts in the top 0.1 percent concepts that an article's title or abstract uses within 5 years of the concept's vintage year
Multi-disciplinary	Diversity of fields cited: One minus Herfindahl index of references using MeSH (level 4) as field indicator
Distance from frontier	Average age of references

Use of Important, New Ideas (N-Grams)

Concept	1st Year	Mentions
polymerase chain reaction	1986	11849
rtpcr	1989	7703
hiv1	1987	6848
human immunodeficiency virus	1986	6300
paclitaxel	1993	5517
knockout mice	1992	5478
transcriptionpolymerase chain reaction	1989	4687
realtime pcr	1996	4460

But beware of disparities!
2022 *Nature*

Article

Women are credited less in science than men

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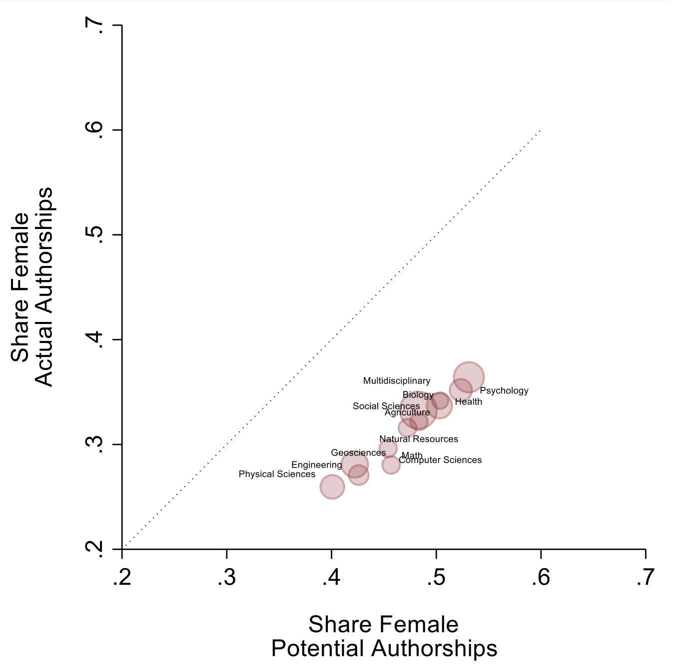
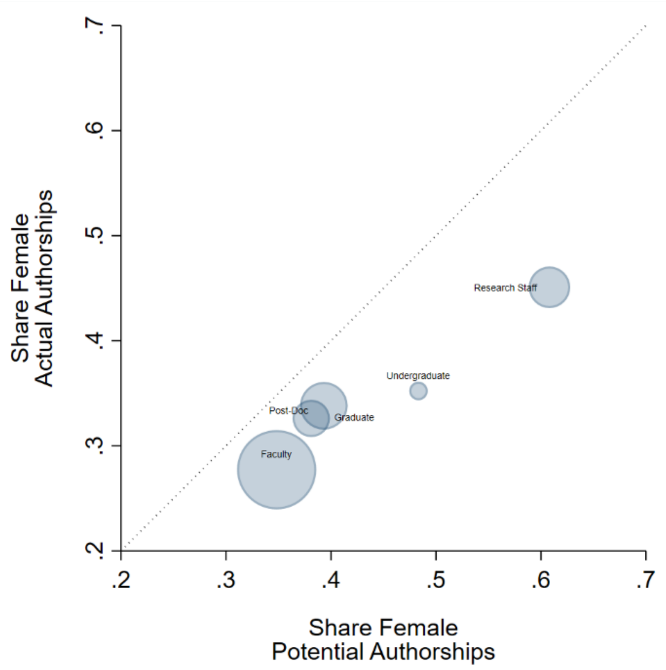
Open access
Check for updates

Matthew B. Ross[1], Britta M. Glennon[2,3], Raviv Murciano-Goroff[4], Enrico G. Berkes[5], Bruce A. Weinberg[3,5] & Julia I. Lane[6]✉

There is a well-documented gap between the observed number of works produced by women and by men in science, with clear consequences for the retention and promotion of women[1]. The gap might be a result of productivity differences[2–5], or it might be owing to women's contributions not being acknowledged[6,7]. Here we find that at least part of this gap is the result of unacknowledged contributions: women in research teams are significantly less likely than men to be credited with authorship. The findings are consistent across three very different sources of data. Analysis of the first source—large-scale administrative data on research teams, team scientific output and attribution of credit—show that women are significantly less likely to be named on a given article or patent produced by their team relative to their male peers. The gender gap in attribution is present across most scientific fields and almost all career stages. The second source—an extensive survey of authors—similarly shows that women's scientific contributions are systematically less likely to be recognized. The third source—qualitative responses—suggests that the reason that women are less likely to be credited is because their work is often not known, is not appreciated or is ignored. At least some of the observed gender gap in scientific output may be owing not to differences in scientific contribution, but rather to differences in attribution.

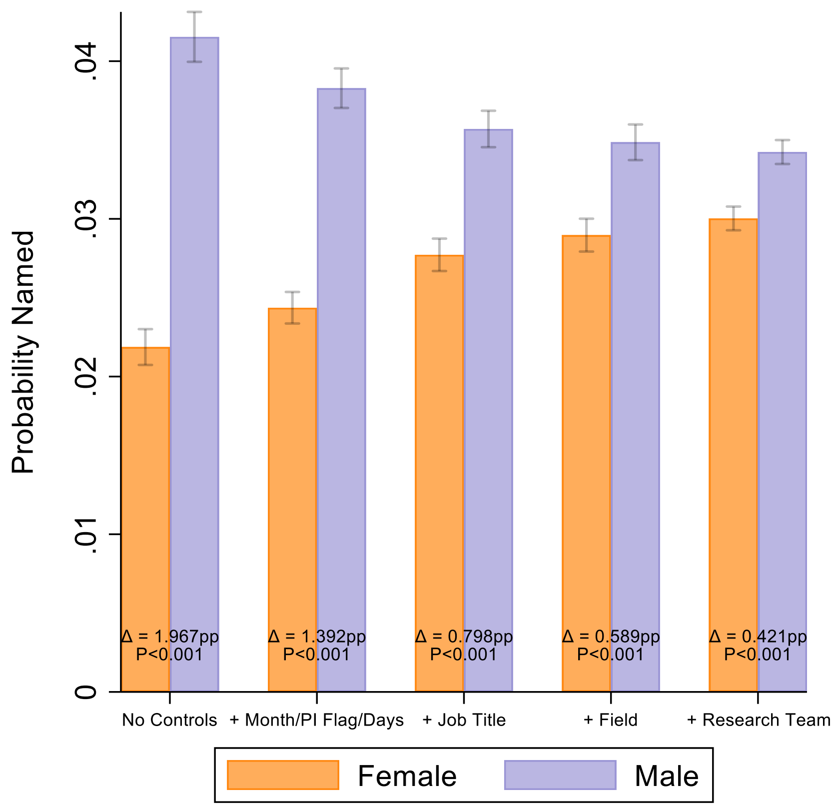
Women less likely to be named in all fields (L) and all occupations (R)



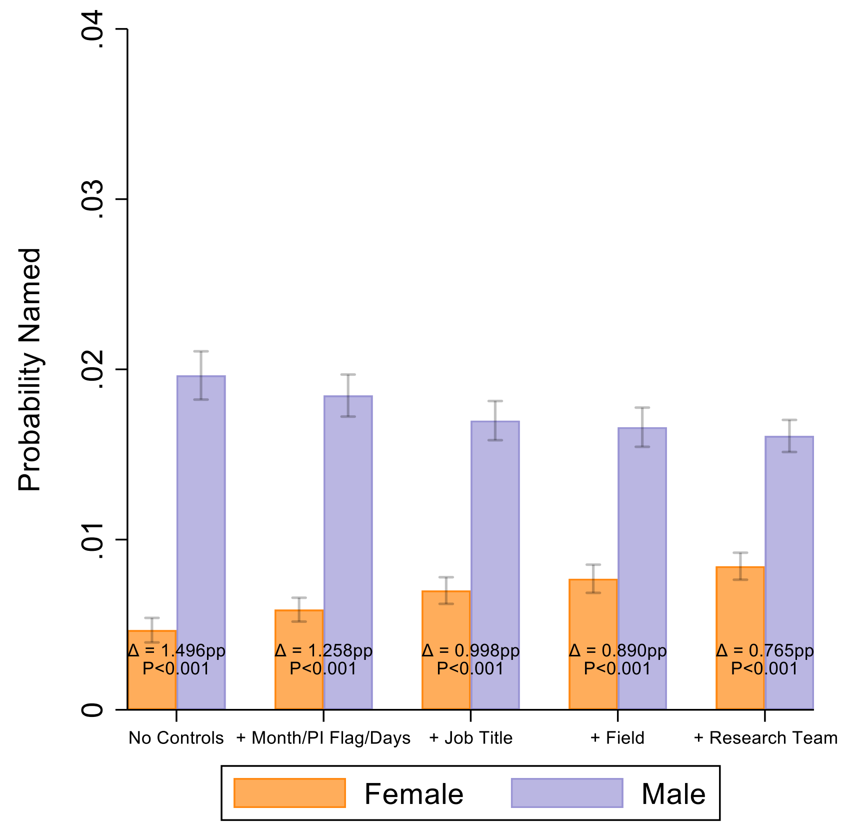


Gender Gap in Attribution

$$P[named_{i,t,e,l} \mid \ldots] = \beta_0 + \beta_1 female_{i,e} + X_{i,e} + M_{i,t} + O_{i,e} + Team_{i,l} + \mu_{i,t,e,l}$$



Articles



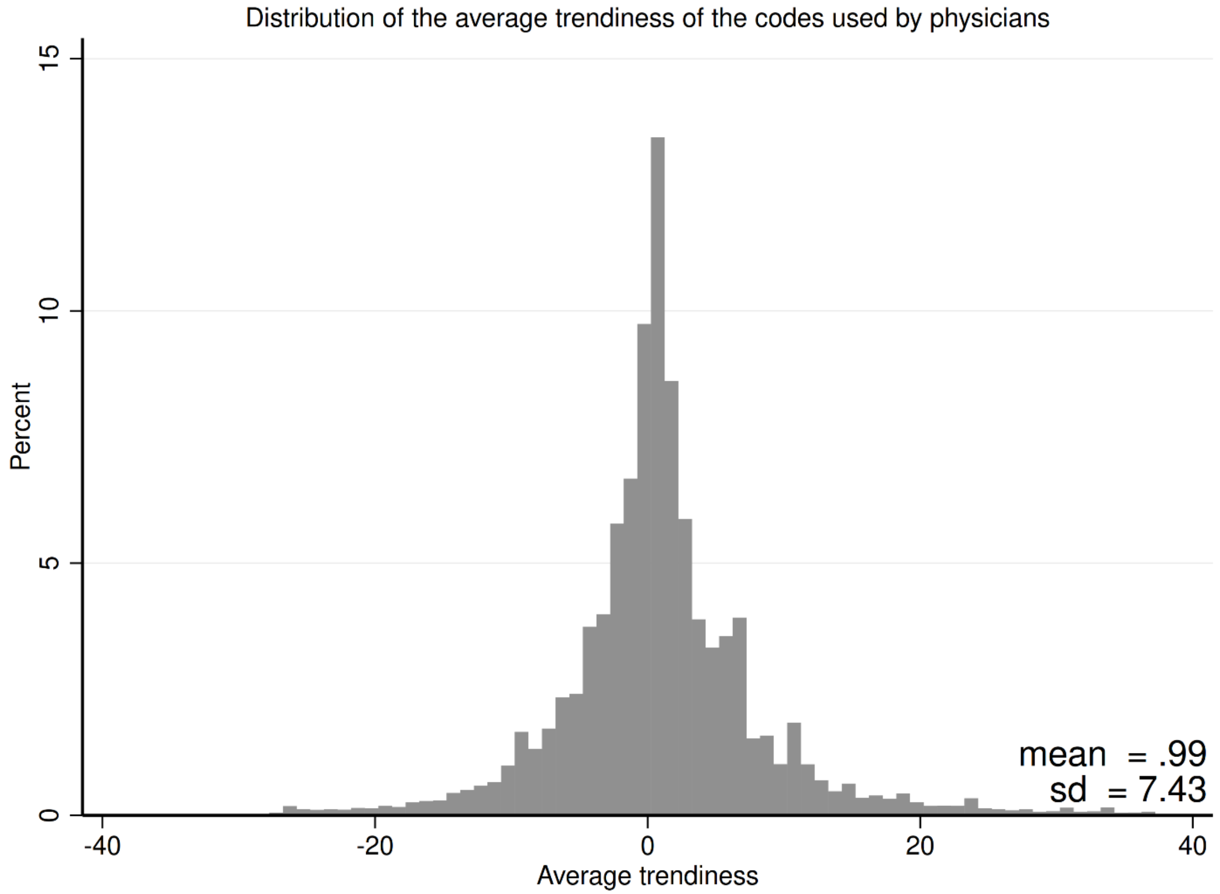
Patents

Bands give 95% confidence intervals.

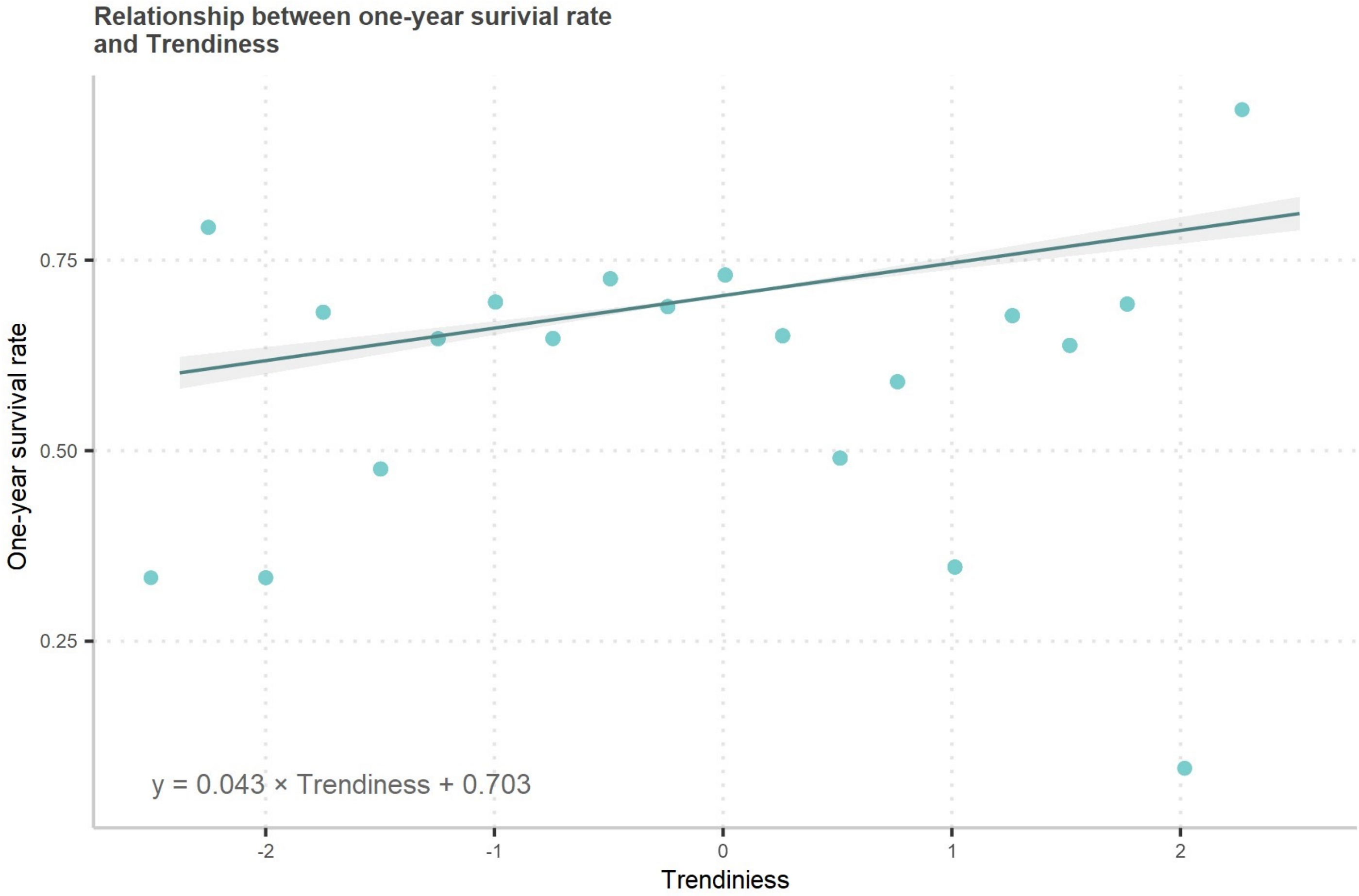
Adoption of Promising New Practices

- Advances are only valuable if used
- Get utilization from Medicare Claims data
- Identify promising new ideas using change in adoption among all physicians conditional on diagnosis
  - Holds for other measures

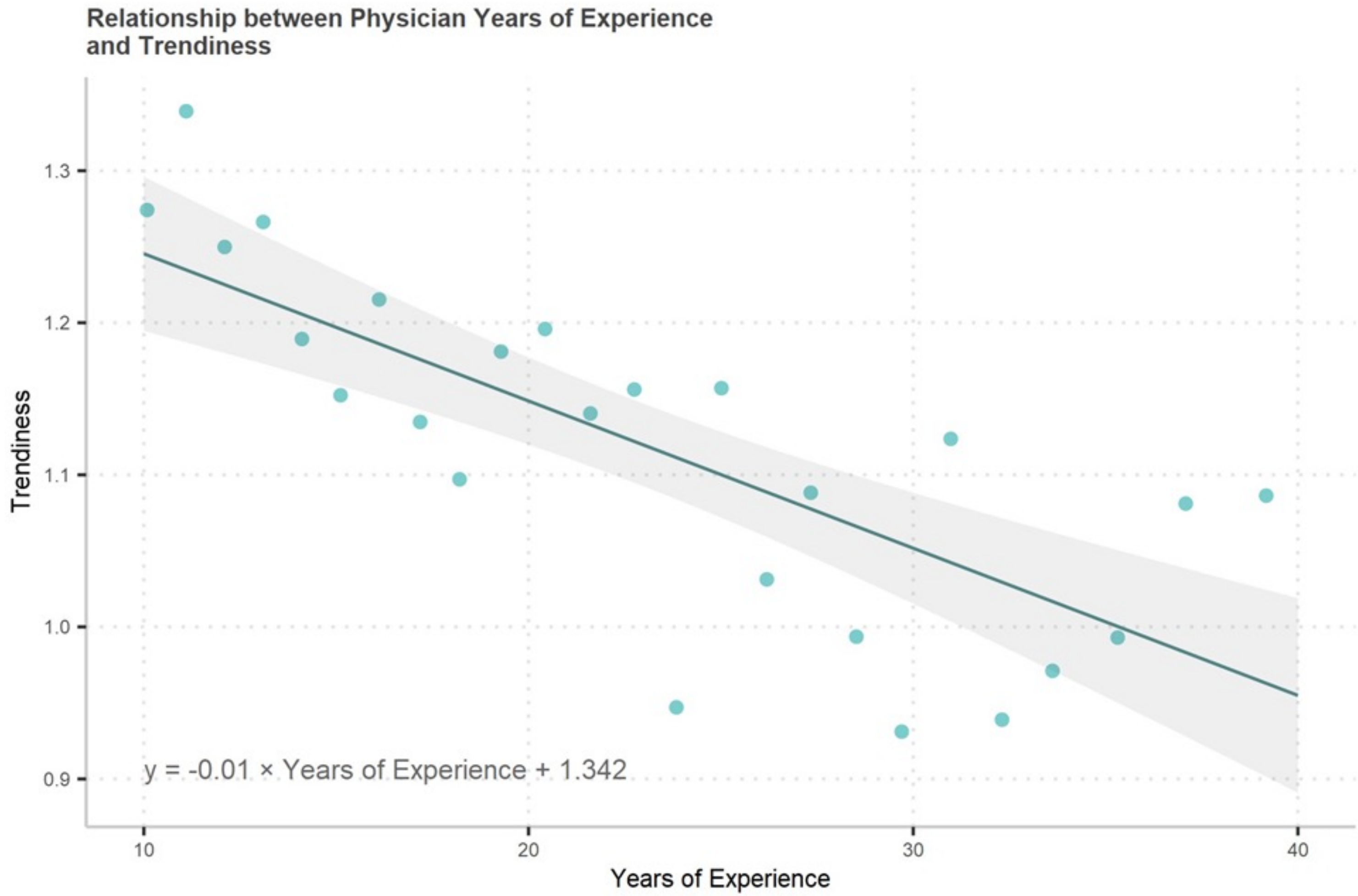
There is Large Variation in Adoption of Promising Codes



Promising Codes are Associated with Better Outcomes



Use of Promising Codes Declines with Experience



Where next?

So where does this leave us?

- Some of this ought to be implementable
- Impact metrics
- Measures of clinical relevance
- Tracking people (to some extent)

- Some of this requires experts
- But I think people could be interested

Thinking strategically

- You are looking for answers; We are looking for data. NSF is looking for policy variation.
- Seems like a win-win-win
- This could be a collaborative process
- Only the largest funders would want to do themselves
- You are uniquely positioned to do this
- While a lot of government funders could do this, they report to Congress…

Guiding principles

- You get what you pay for (in 2 senses)
- The obvious sense, but more importantly…
- People respond to incentives. Give them the right ones!

- Automate things!
- It is possible to do much of this algorithmically
- High fixed cost, but low marginal cost

Thank you!

The Teams

Innovation in an Aging Society

Pierre Azoulay, MIT
Jay Bhattacharya, Stanford
Wei Cheng, East China Science & Tech
David Blau, OSU
Katy Borner, IU
Ina Ganguli, U Mass - Amherst
Josh Graff Zivin, UCSD
John Ham, NU Singapore
Robert Light, IU
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Alison Nunez, SUNY – Albany / Coleridge
Mikko Packalen, Waterloo
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Joe Staudt, OSU / Census
Vetle Torvik, UIUC
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Nathan Goldschlag, Census
Josh Hawley, OSU
Ron Jarmin, Census
Gabi Jiang (OSU)
Christina Jones, AIR
Kunho Kim, PSU
Julia Lane, NYU
Madian Khabsa, Microsoft
Barb McFadden Allen, CIC
Christopher Morphew, Iowa
Rebecca Rosen, NYU
Matt Ross (Claremont Graduate)
Jason Owen-Smith, UMich
Nik Zolas, Census

Characteristics of Transformative Research

- **Radical, Generative – Generates new paradigms and scientific fields.** Introduction and use of heavily-used new terms (n-grams)
- **Radical, Destructive – Makes existing work less salient.** Age of backward citations
- **Risky.** Variance of forward citations
- **Multidisciplinary.** Breadth of articles referenced and of heavily-used new terms used
- **Wide Impact.** Breadth of forward citations and new terms introduced
- **Growing Impact.** Time to forward citations
- **High Impact.** Counts (mean and various percentiles) of forward citations