# The Challenge and the Opportunity of Designing & Executing Field Experiments for Innovation Systems

Karim R. Lakhani | k@hbs.edu | @klakhani

Harvard Business School | Laboratory for Innovation Science at Harvard | NBER

# Where is the "Science" that Drives the Scientific Enterprise?

Karim R. Lakhani | k@hbs.edu | @klakhani

Harvard Business School | Laboratory for Innovation Science at Harvard | NBER

# One (Linear) View of the Scientific/Innovation Enterprise

1. Scientists have ideas
2. Collaborations form (inside/across labs)
3. Proposals generated
4. Peer evaluation for funding
5. Experiment & execution
6. “Significant” results?
7. Write paper | patent application
8. Peer evaluation for publication | Patent assessment
9. Publication | Patent
10. Citations | Tech Transfer

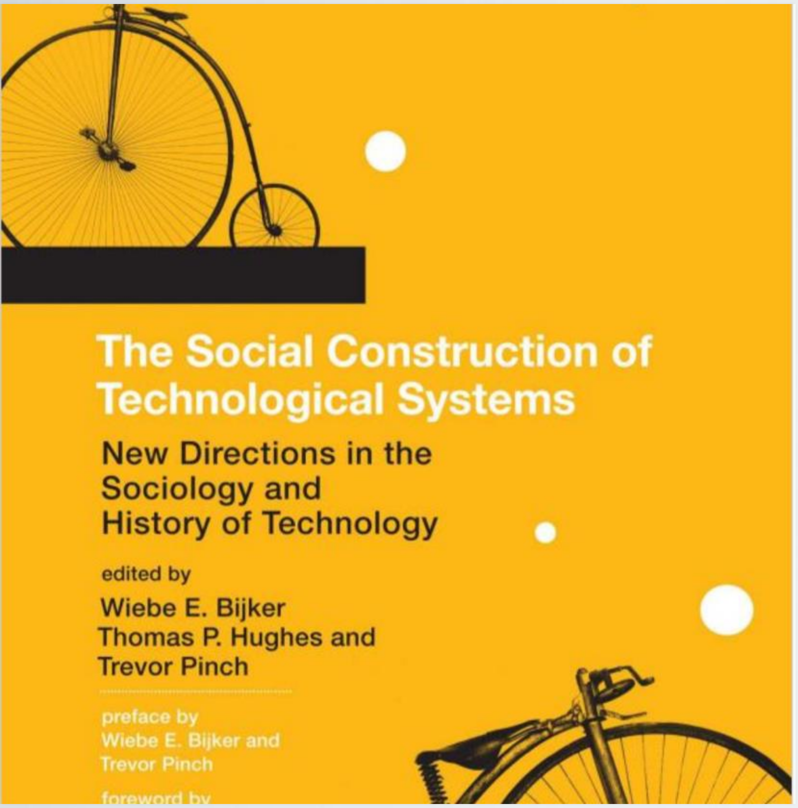
# Scholarly & Policy Myopia Focus Only On "Easily" Found Observables & Outcomes

1. Scientists have ideas
2. Collaborations form (inside/across labs)
3. Proposals generated
4. Peer evaluation for funding
5. Experiment & execution
6. "Significant" results?
7. Write paper | patent application
8. Peer evaluation for publication | Patent assessment
9. **Publication | Patent**
10. **Citations | Tech Transfer**

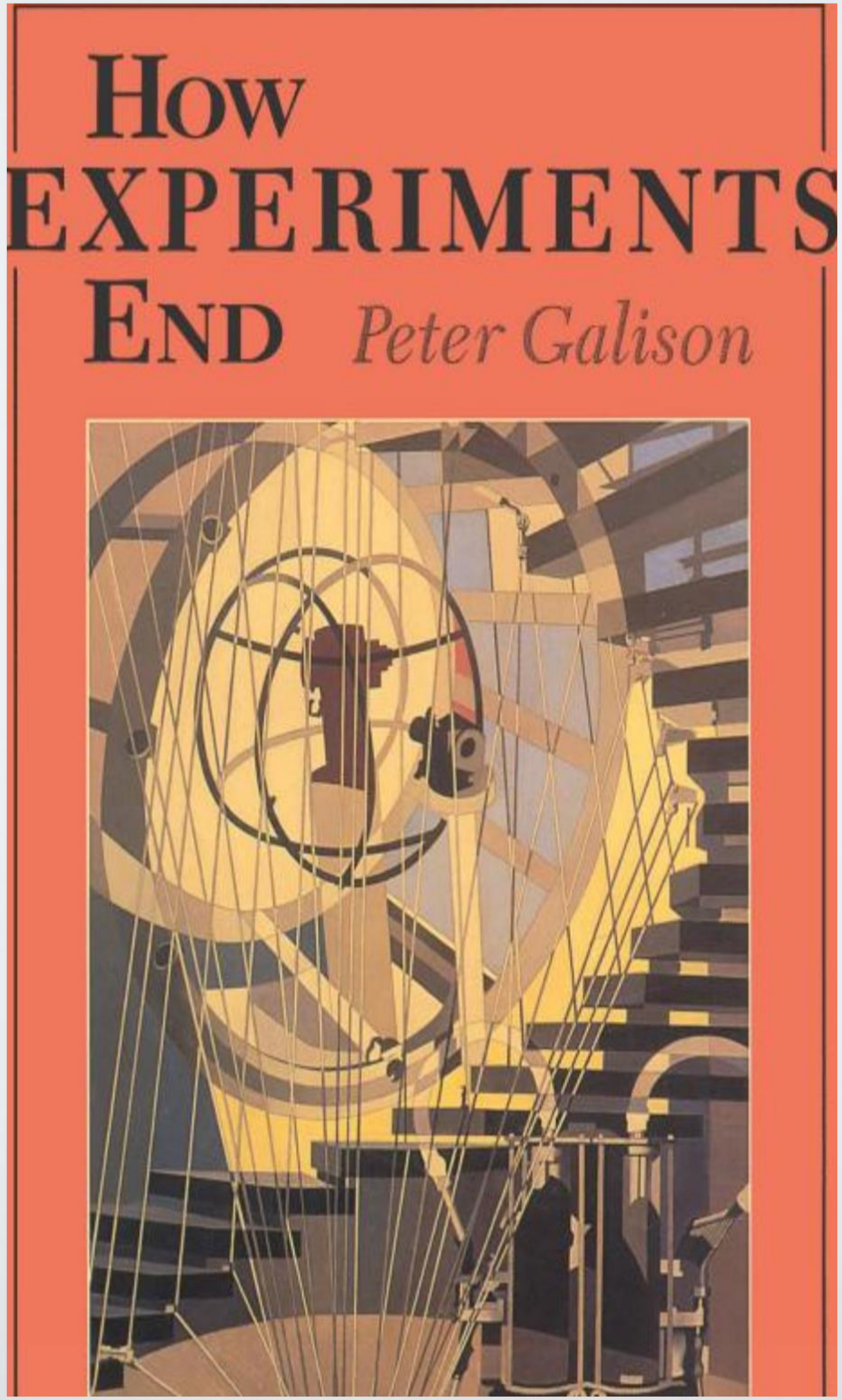
# But We Might As Well Be Counting "Meat Pies?"

- Parallel literature on Social Construction of Technology critiques innovation studies for "black boxing" scientific production:

- "This literature is in some ways reminiscent of the early days in the sociology of science, when scientific knowledge was treated like a "black box" and, for the purpose of such studies, scientists might as well have produced meat pies" (Pinch and Bijker, 2012, p15)








# Qualitative Sociological Studies of Science Hint at Large Causal Density Driving "Outcomes"

# Some Questions That Can Open Up The Black Box

Scientific Enterprise

1. Scientists have ideas
2. Collaborations form (inside/across labs)
3. Proposals generated
4. Peer evaluation for funding
5. Experiment & execution
6. "Significant" results?
7. Write paper | patent application
8. Peer evaluation for publication | Patent assessment
9. Publication | Patent
10. Citations | Tech Transfer

**Open Questions**

1. Good versus bad? More? How? Why?
2. **Failed? How many? Matching|Screening Mechanisms? Search Costs**
3. Success rates?
4. **Biases in evaluation**
5. Causes for failure?
6. Null results?
7. Stuck writing | No uptake from TLO
8. Biases in evaluation
9. Where published? Why?
10. Who cites? Why?

# Examining How Scientific Collaborations Form

# Collaborators in this Paper Included Economists & Medical Researchers


**KEVIN BOUDREAU**

Northeastern University



**TOM BRADY**

MGH



**INA GANGULI**

University of Massachusetts, Amherst



**PATRICK GAULE**

University of Bath



**EVA GUINAN**

Dana Farber



**ANTHONY HOLLENBERG**

Cornell University



The Review *of* Economics *and* Statistics

VOL. XCIX — OCTOBER 2017 — NUMBER 4


A FIELD EXPERIMENT ON SEARCH COSTS AND THE FORMATION OF SCIENTIFIC COLLABORATIONS

# Motivation: Collaborations Increasingly Dominant in Academic Science

- Teams have become the preferred mode for knowledge production in the sciences (Jones et al. 2008)
- Scientists self-select and match with other collaborators (typically no managerial or centralized interventions)
- Some evidence that decreasing communication costs may lead to more dispersed collaborations (Agarwal & Goldfarb 2008; Jones et al. 2008; Adams et al. 2005)
- Yet pre-existing social ties may dominate collaboration forming (Fafchamps  et al. 2010; Azoulay et al. 2010)
- Studies primarily driven by publication data - *after* team formation and some success
- *Ex-ante* evidence of all potential collaborators typically not available

# Finding Collaborators can be a Challenge

**"We don't understand the universe of individuals who might actually complement what we do...Having more information and knowledge about who else might be a good collaborators could potentially enrich what we do."**

- William Chin, (former) Executive Dean for Research, HMS

*I see by the current issue of 'Lab News' Ridgeway, that you've been working for the last 20 years on the same problem I've been working on for the last 20 years.*

# Intuition for Field Experiment

- Exogenously vary information available to research scientists concerning potential collaborators
- Randomly allocate participants to breakout rooms at a biomedical research symposium
- Outcome: likelihood of collaboration

# Field Experiment Implementation

- Modified and took over an internal grant funding opportunity for Harvard biomedical researchers
- Funding opportunity conditional on participation in an interactive research symposium - randomization to breakout rooms occurred at this event
- Collaboration measured as appearing as a co-applicant on a grant application

# Advanced Imaging Pilot Grant Opportunity

Layered the experiment onto a planned Harvard Catalyst Pilot grant program

Grant focussed on creating clinical uses of advanced imaging technology (PET, Physiological MRI, Optical)

$800,000 available to support 15 pilot grants + several concept development prizes of $2000 each

# Grant Application Process Underlying Data for Experiment

- December 5 - 19, 2011: Registration & submission of Statement of Interest
- January 6, 2012: Participants invited to attend a symposium and proceed in grant process
- January 31 - February 2, 2012: Advanced Imaging Symposia at Harvard Innovation Lab
- February 6, 2012: Grant competition opens
- March 8, 2012: Proposals due
- May 2012: Reviews completed and winners announced

# The Advanced Imaging Symposia

- 402 total participants across 3 nights - January 31, February 1, and February 2, 2012 at the Harvard Innovation Lab
- First a 30-minute welcome address - pilot grant opportunity, the agenda, intro to imaging tools and technologies.
- Breakout sessions in 4 rooms - participants randomly assigned to specific rooms (28 to 43 participants per room)
- Breakout sessions divided into two parts - each 45 minutes long with a 15-minute break in between (with food)

# Results

- Randomized variation in information about potential collaborators significantly impacts pair-level co-application for grants
- Reducing information and search costs (by being in the same breakout room) increases probability of collaboration by 75% (95% CI: 4% - 112%)
- Impacts those with same clinical areas (scientific space) - homophile
- Caveat: Collaboration is a rare event - so effect is driven by a relatively small number of collaborations

# Implications

- Information acquisition about potential scientific collaborators is costly and related search frictions impact collaboration propensity
- Implemented experiment in a “best-case” scenario: same institution, geographic proximity, funding availability, IT investments
- Exogenous reduction in information acquisition costs - increases the probability of collaboration by 75%
- Treatment effect (90 mins at symposium) is 30% of effect of being in same hospital and working in same clinical area
- Highlight potential differences between ***formation*** (matching) versus ***execution*** (joint production) of distributed collaboration


# Biases in Evaluating Scientific Ideas

Collaborators in this Paper Included Economists, Information Scientists & Medical Rese


KEVIN BOUDREAU

Northeastern University



EVA GUINAN

Dana Farber



CHRISTOPH RIEDL

Northeastern University



MANAGEMENT SCIENCE

*Articles in Advance*, pp. 1–19

ISSN 0025-1909 (print) | ISSN 1526-5501 (online)

informs

http://dx.doi.org/10.1287/mnsc.2015.2285




Looking Across and Looking Beyond the Knowledge Frontier: Intellectual Distance, Novelty, and Resource Allocation in Science

# Motivation: Expert Evaluation Extensively Used to Evaluate (Competing) Innovation Projects and Resource Allocation in Science & Industry

- Expert evaluation used to disburse >$40B/year in grant funding in US (NIH & NSF); Thousands of evaluators annually
- Evaluations determine “where” on the technical frontier innovation and research occurs
- Natural scientists unlikely to continue research that is rejected for funding - between 33% to 48% - Cole et al. (1981)
- Evaluation of ideas is understudied in economics of innovation literature

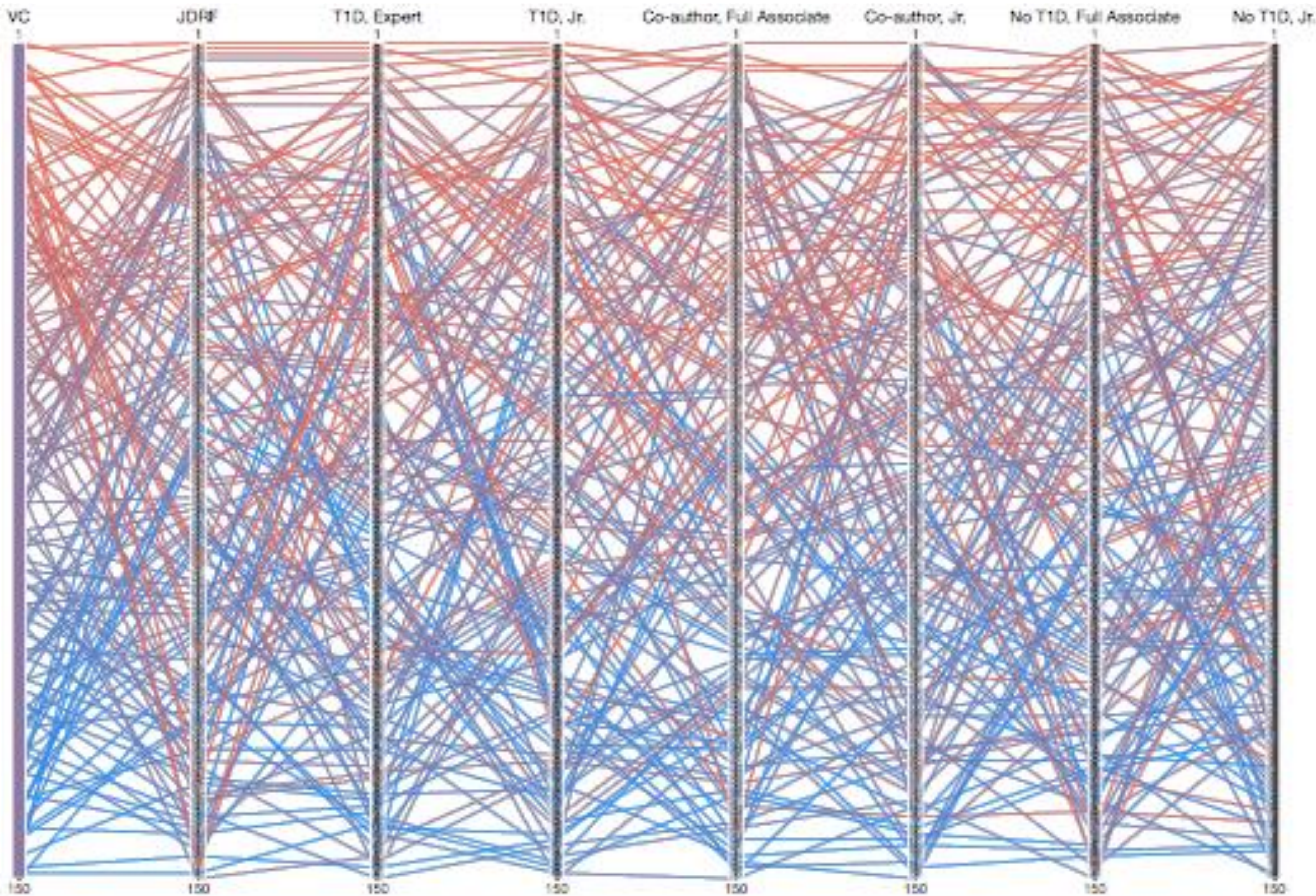
# Frontier Research Ideas Face Resistance from Experts (Example in Azoulay et al. 2011)

- Mario Capecchi - University of Utah applies for NIH grant in 1980
- Proposes three projects; two building on past work - one **novel** project: gene targeting in mammalian cells
- NIH Evaluators unanimously recommend that novel project be dropped - give grant with misgivings
- Ignores advice, drops first two projects and goes ahead with work on third
- Shares Nobel Prize in 2007 for knock-out mice

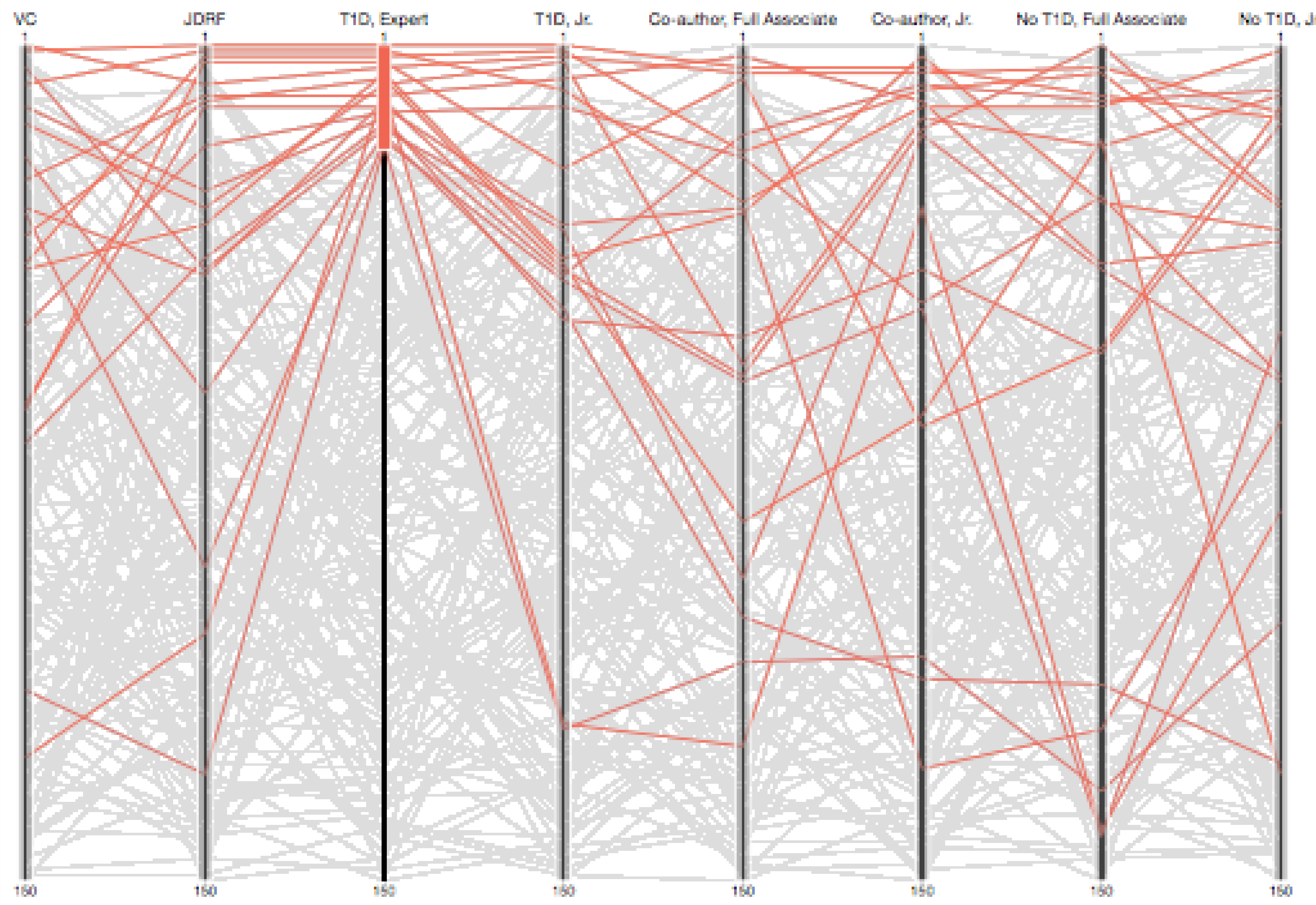
# Study Design & Findings

- Research Question: Does intellectual distance related to the knowledge frontier impact scientific proposal evaluation from experts?
- Three broad literature streams offer explanations: 1-Agency problems & private interests; 2-Decision making under uncertainty; 3-Expert cognition and bounded rationality
- Design and implement test by experimenting with a grant review process at a (very) large medical school system for endocrine-related research (Type-1 Diabetes)
- Features of design and analysis:
  - Multiple proposals (150): multiple evaluators (142 faculty members)
  - Random assignment & "triple blind" evaluation
  - Observe individual identities, evaluations, proposal characteristics
  - Precise and granular measures

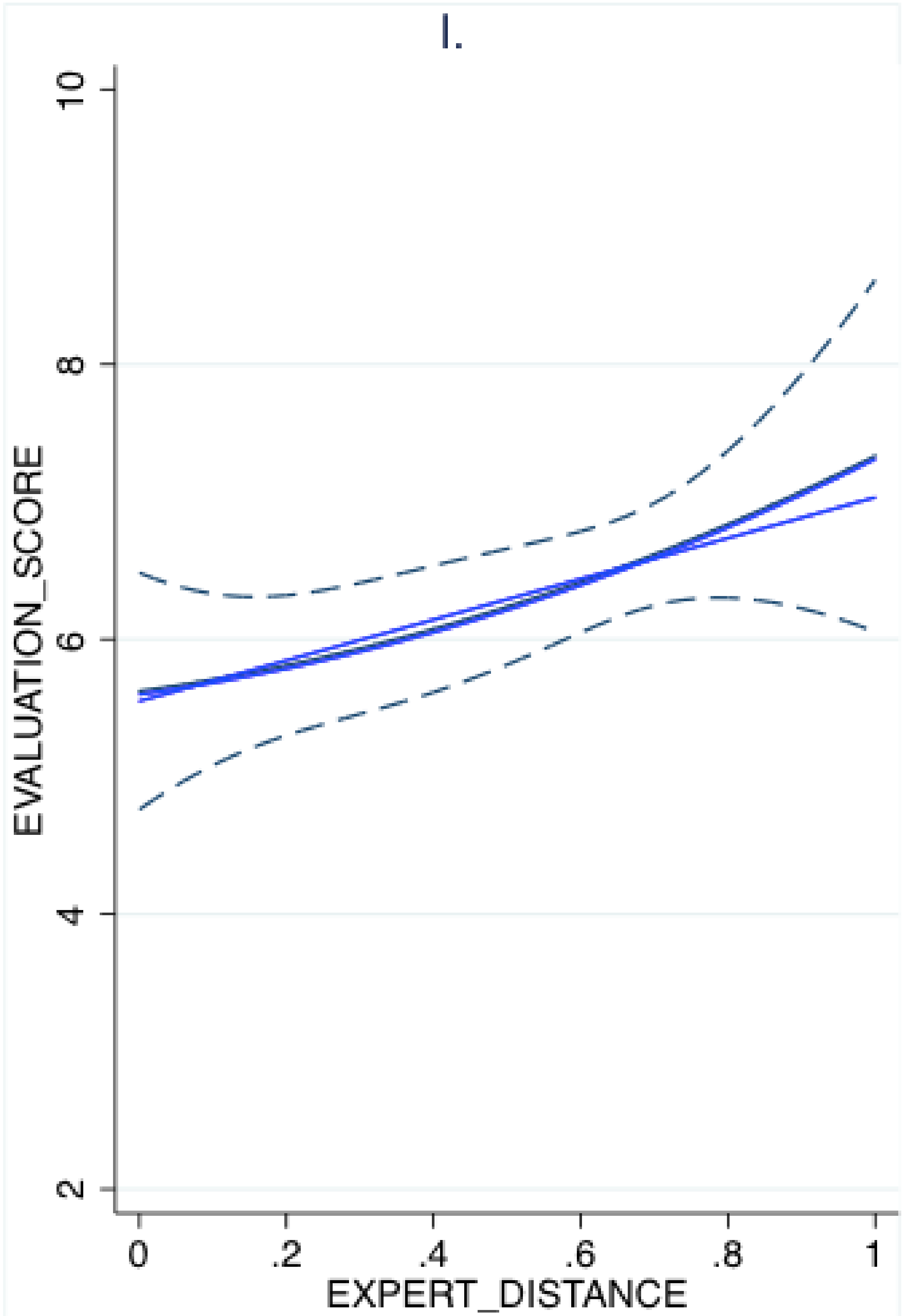
# Wide Diversity of Evaluations



# Top Ten Evaluations of T1D Experts



# Main Findings: Intellectual Distance Systematically Affects Scores



# Issues in Designing and Executing Innovation Experiments (Boudreau & Lakhani, 2016 (NBER IPE Paper))

- Multiple Mechanisms Shaping Innovation and the Knowledge Production Function
- Unit of Analysis, Replication, and Sample Size
- Selection versus Treatment Effects
- Institutional Design Treatments & Counterfactuals
- Representativeness, Validity & Fine-Grained Measures
- Cooperation with the Sponsoring Agency
- “A little bit of randomization goes a long way”

# Opportunity to Study Science and Innovation “Scientifically”

- Jameel Poverty Action Lab provides template for organizing scientific studies:
  - “Our mission is to reduce poverty by ensuring that policy is informed by scientific evidence. We do this through research, policy outreach, and training.”
  - 911 ongoing or completed randomized evaluations in 79 countries
  - Cooperation with governments and NGOs
- How can universities, corporations, policy makers, funders and social scientists work together to rigorously study science and innovation?

Thanks!
Questions/Comments?

k@hbs.edu | @klakhani