

# Too Many Papers? Slowed Canonical Progress in Large Fields of Science

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# Too many papers? Slowed canonical progress in large fields of science

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**Johan Chu**

**January 18, 2022**

**Northwestern | Kellogg**



# Slowed canonical progress in large fields of science

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Edited by Kenneth W. Wachter, University of California, Berkeley, CA, and approved August 25, 2021 (received for review December 8, 2020)

In many academic fields, the number of papers published each year has increased significantly over time. Policy measures aim to increase the quantity of scientists, research funding, and scientific output, which is measured by the number of papers produced. These quantitative metrics determine the career trajectories of scholars and evaluations of academic departments, institutions, and nations. Whether and how these increases in the numbers of scientists and papers translate into advances in knowledge is unclear, however. Here, we first lay out a theoretical argument for why too many papers published each year in a field can lead to stagnation rather than advance. The deluge of new papers may deprive reviewers and readers the cognitive slack required to fully recognize and understand novel ideas. Competition among many new ideas may prevent the gradual accumulation of focused attention on a promising new idea. Then, we show data supporting the predictions of this theory. When the number of papers published per year in a scientific field grows large, citations flow disproportionately to already well-cited papers; the list of most-cited papers ossifies; new papers are unlikely to ever become highly cited, and when they do, it is not through a gradual, cumulative process of attention gathering; and newly published papers become unlikely to disrupt existing work. These findings suggest that the progress of large scientific fields may be slowed, trapped in existing canon. Policy measures shifting how scientific work is produced, disseminated, consumed, and rewarded may be called for to push fields into new, more fertile areas of study.

scientific progress | durable dominance | entrepreneurial futility |  
science policy | science of science

A straightforward view of scientific progress would suggest more is better. The more papers published in a field, the

causing faster turnover of field paradigms, a deluge of new publications entrenches top-cited papers, precluding new work from rising into the most-cited, commonly known canon of the field.

These arguments, supported by our empirical analysis, suggest that the scientific enterprise's focus on quantity may obstruct fundamental progress. This detrimental effect will intensify as the annual mass of publications in each field continues to grow—which is almost inevitable given the entrenched, interlocking structures motivating publication quantity. Policy measures restructuring the scientific production value chain may be required to allow mass attention to concentrate on promising, novel ideas.

This study focuses on the effects of field size: The number of papers published in a field in a given year. Previous studies have found that citation inequality is increasing across a range of disciplines (11), at least partially driven by processes of preferential attachment (12, 13). Papers do not always maintain their citation levels and rankings over the years, however. Disruptive papers can eclipse prior work (4) and natural fluctuations in citation numbers can upset rankings (14). We predict that when fields are large, the dynamics change. The most-cited papers become entrenched, garnering disproportionate shares of future citations. New papers cannot rise into canon by amassing citations through processes of preferential attachment. Newly published papers rarely disrupt established scholarship.

Two mechanisms underlie these predictions (15). First, when many papers are published within a short period of time, scholars are forced to resort to heuristics to make continued sense of the field. Rather than encountering and considering intriguing new ideas each on their own merits, cognitively overloaded reviewers

Significance

# Received wisdom: Competition hurts dominants

Exclusive access to resources and markets keeps dominants on top

Competition inexorably eats away at dominant advantage

# What I will tell you today: Competition benefits dominants

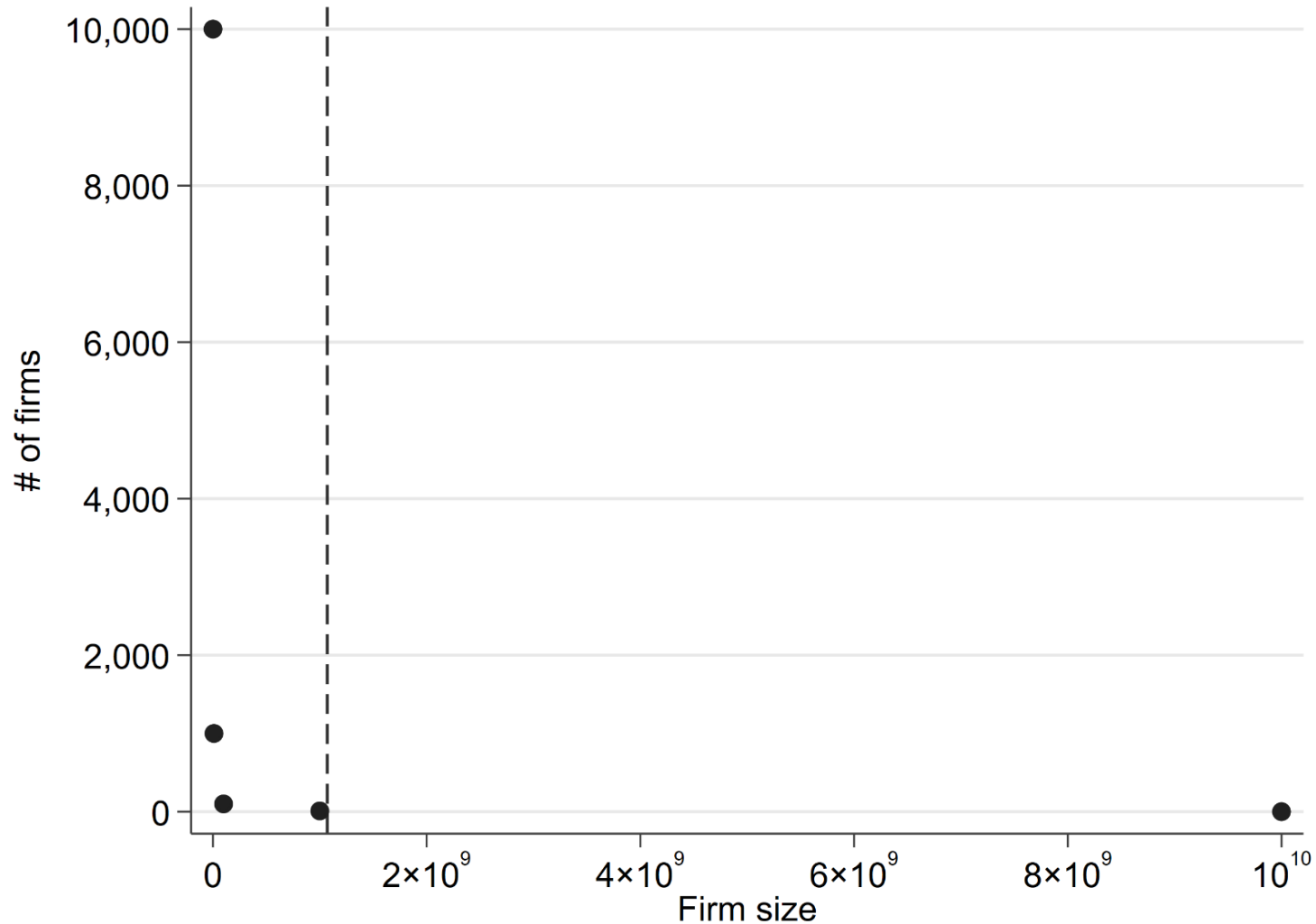
**(Under certain conditions)**

Entrenches existing dominants atop the distribution

Prevents upstarts from overtaking dominants

Technologies for directing mass attention important

# Background: Dominants are different





# Dominants are different

1. Above shocks
2. Distinctive
3. No competition from above

→ React differently to competitive shocks

→ ... and policy changes

# I. Dominants benefit from increased competitive entry

(Chu 2018, Strategy Science)

1. Consumer paradox of choice
2. Legitimacy/exemplar effects
3. Competitor attention and competitive release
4. The impossible middle (reverse resource partitioning)
5. Better at exploiting new opportunities & learning from others

## II. Non-dominants suffer

(Chu, 2018, Strategy Science)

Intensified competition between  
non-dominants trammels  
non-dominant growth rates

Reduces chance of any  
non-dominant overtaking  
dominant



# Settings where durable dominance is in effect?

Mutual funds

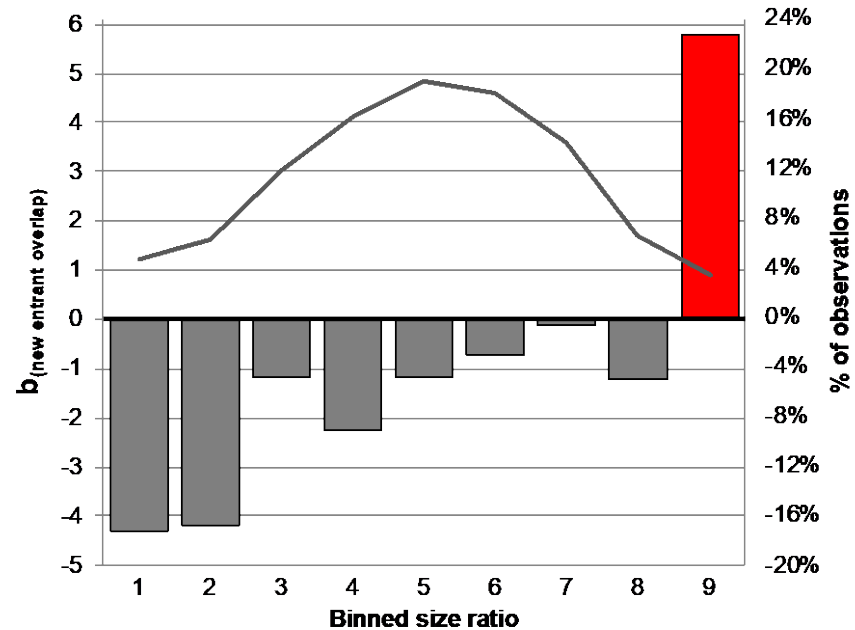
Beer

Tom Cruise & Radiohead

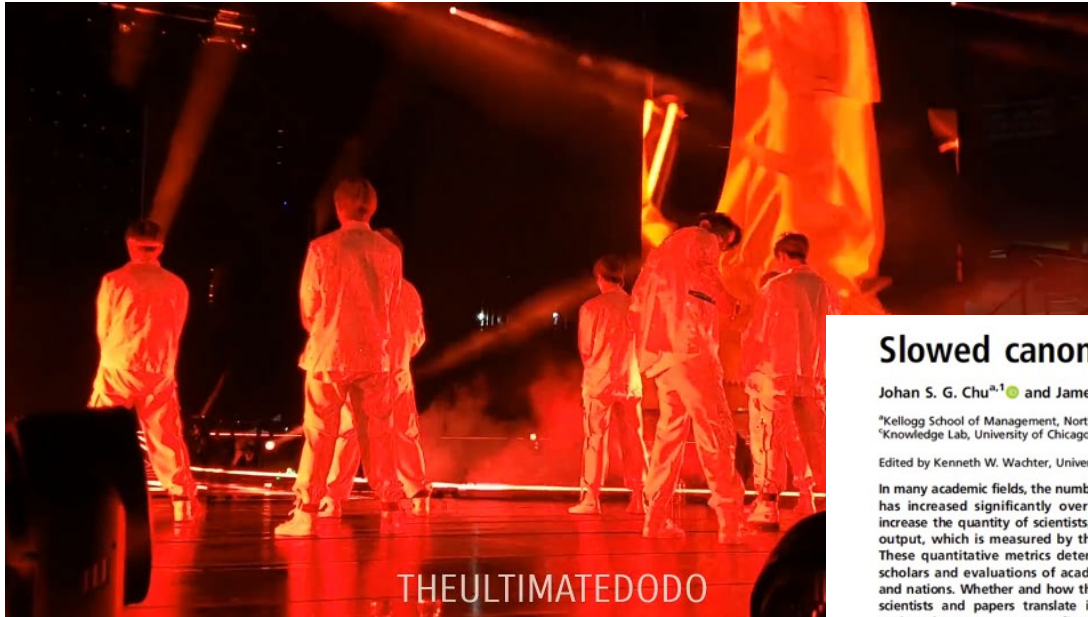
Old scientific theories

Ultra-wealthy

Et cetera, et cetera, et cetera



# Recent studies: Directing mass attention in K-pop and Science



## Slowed canonical progress in large fields of science

Johan S. G. Chu<sup>a,1</sup> and James A. Evans<sup>b,c,d</sup>

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Significance



# Science is getting bigger

Orders of magnitude larger than even a decade ago;  
largest fields over 100,000 papers/year

Quantity measured and rewarded, emphasized in policy:

- # of scientists, papers, research \$
- Affects careers, rankings (department, institution, country)
- “Quality” also measured quantitatively by # citations

# Received wisdom: More science = more progress

More ideas in the marketplace, a “thousand flowers” blooming (Pfeffer)

Over time, build up to a “critical” (Bak, Tang, & Wiesenfeld) state

A few articles can then trigger a “paradigm shift” (Kuhn)

# Or not.

Two major mechanisms:

- 1. Cognitive overload:** To make sense of flood of papers, readers and reviewers rely on relating to existing exemplars
  - Authors pushed to frame work firmly in relationship to existing “intellectual badges” (Stinchcombe, 1982)
- 2. Sub-critical dynamics:** New ideas arriving too fast prevent field from reaching critical state
  - No new idea can rise into canon through localized diffusion and preferential attachment

# Data: Web of Science

Papers published 1960–2014

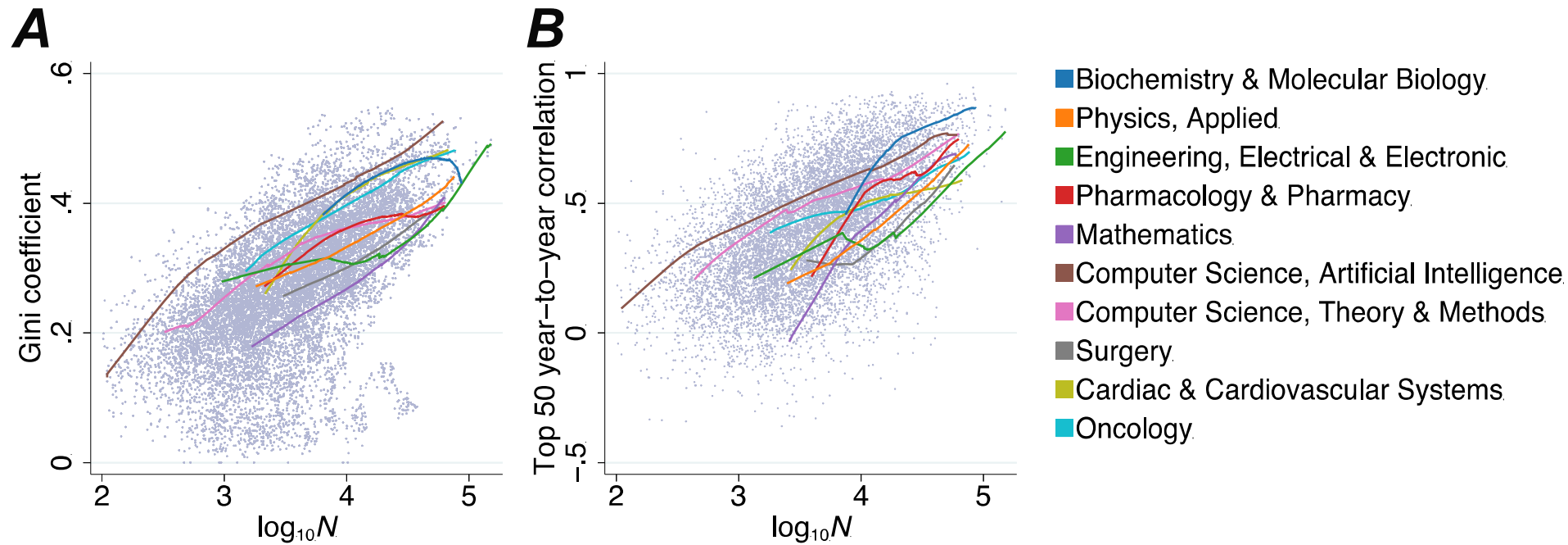
90,637,277 papers; 1,821,810,360 citations

WoS classifies field/major subfields into 241 “subjects”

# Results:

## 1) Most-cited papers become durably dominant

New citations cite most-cited; canon ossifies

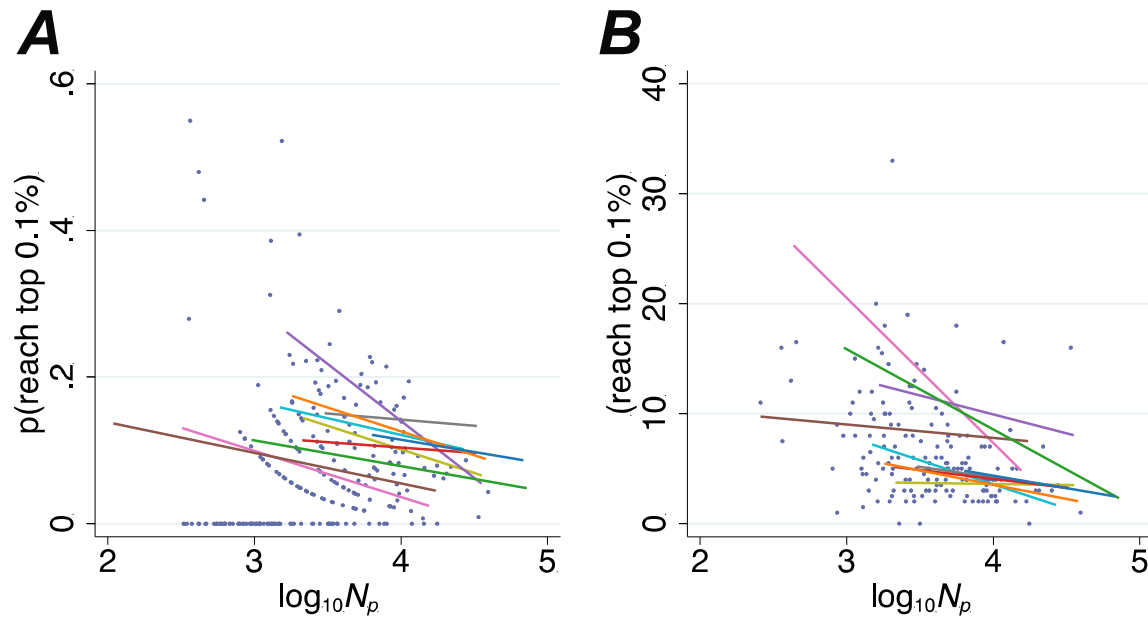


\* Dots are subject-years, lines for 10 largest fields



## 2) Entrepreneurial futility

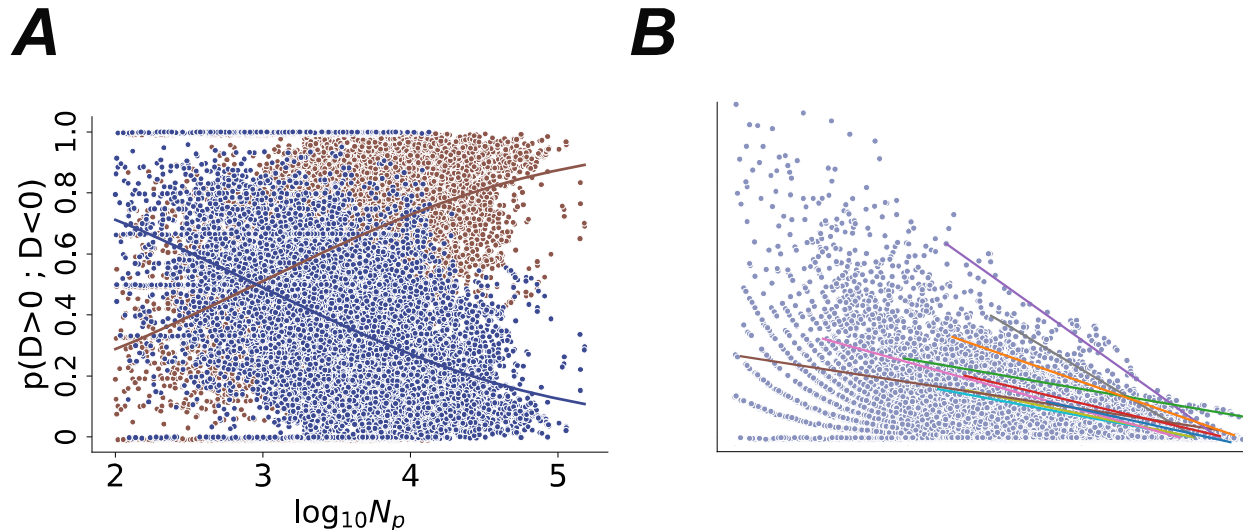
Probability of becoming most-cited falls; when achieved, not through gradual cumulative process



\* Dots are subjects in 1980; lines for 10 largest fields by year  $\leq 2000$

### 3) Less disruption

More developing (not disrupting) papers; even disrupting papers fail to disrupt



\* A: Blue dots/line: Proportion of disrupting papers; Red: Developing  
B: Dots: subject-years; Lines: ten-largest field linear trends

# Implications for the practice of science

Too many papers: Canon ossifies

- New ideas cannot be carefully considered against old
- Slow processes of cumulative advantage can't work to select useful innovations

Are we stuck on increasingly less-productive terrain?

- Most-cited paper (Bradford, 1976) in molecular biology hasn't changed since 1982

For the practicing scientist: Very hard to change a large field from inside. May need to go outside field (or academia)

# Policy implications

De-emphasizing quantity impossible. What can we do then?

- More hierarchy in journals; top journals devoting pages to less canonically-rooted work
- Reward & promotion systems favoring fewer, deeper, more novel contributions
- Measure of novelty vis-à-vis canon used in evaluations of grants, papers, and scholars
- Revamped graduate training

# Broader takeaway: Durable dominance in mass attention-central markets

Existing dominants enjoy tremendous advantage

Limited consumer search capacity means more competition (more papers published, songs released, more mutual funds available, etc.) benefits dominants

... and hurts non-dominants



# Thank you!

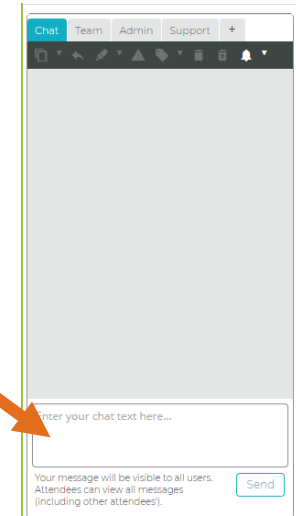
Further questions: [johan.chu@kellogg.northwestern.edu](mailto:johan.chu@kellogg.northwestern.edu)

- PNAS paper on science:  
<https://www.pnas.org/content/118/41/e2021636118>
- Strategy Science paper on theory of durable dominance:  
<https://doi.org/10.1287/stsc.2018.0055>
- My page on Kellogg's website:  
[https://www.kellogg.northwestern.edu/faculty/directory/chu\\_johan.aspx](https://www.kellogg.northwestern.edu/faculty/directory/chu_johan.aspx)

Q&A

Perigon

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