The role of young researchers in the knowledge creation process in science

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Understanding Organization of Science

- Increasing interest in organization and economics of science (Stephan, 2010, Cummings and Kiesler).
- Especially with increase in team science (Wuchty, et al., 2007).
- In addition, concerns about scientific labor markets and need to encourage young STEM researchers (NAS, 1998, BRWWG, 2012)

Role of Young Scientists

- Research Question: What is the role of young scientists in scientific research?
  - Are post-docs a conduit for new knowledge and serendipitous findings, or are they largely extensions of the PI? (Vogel, 1999, BRWWG, 2012).
- Vary by field? By country?
- Grad students versus Post-docs?
- What is the impact of papers with young first authors?
  - Types of knowledge used?
  - Impact on field (highly cited)?

Japan-US Scientists Survey

- Survey of Japanese/US authors on scientific papers
- Ask about details of research project that produced the paper
- Including project team composition
- And, knowledge inputs
- Also bibliometric data on citations (top 1% v. others)

The population of the survey

- Articles and letters in Science Citation Indexes-Expanded (Thomson Reuters)
- Time window: 2001 – 2006 (database year)
- Forward citation counts were retrieved on December 31, 2006
- 22 fields in the ESI were adopted
- Sampled about 9000 papers, 1/3 from top 1% in citations (High), and 2/3 from rest of populaiton (Normal)

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Topics covered

- Motivation and the other basic characteristics of the research project: Stokes quadrants, serendipity, and scientific competition
- Knowledge production process: respondent's roles in the project and uses of external knowledge and geographic location of those knowledge sources, and organization of research project
- Research inputs: project duration, funding and sources of funds
- Composition of the research team: rank, organization type, field, country of origin, research skill/specialty, gender, also number of students trained and personnel hired by project as well as authorship rules
- Outputs: number of other papers, patents, licenses, startup firms;
- Scientists' demographics, family status (marital status, children), education and training, mobility, awards, and publication counts

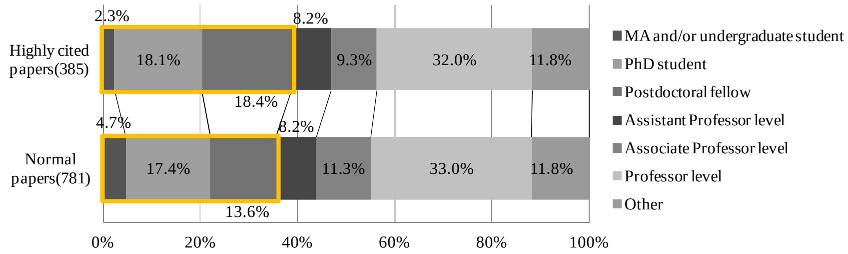
Survey timeline and response rates

- Initial mail outs: September-November, 2010
- Reminder emails: November-December, 2010
- Second (final) reminders: January, 2011
- 2329 responses (as of Jan 28, 2011), out of 8,864 survey targets
- The total response rate is approximately 26% using total mail out as the denominator
  - we may need to adjust this as we finish auditing cases for eligibility
- Fields with over 30% response rate are environment/ecology & geosciences (37%), social science (32.4%) and agriculture, plant, and animal science (31%).
- Response rate in clinical medicine & psychiatry/psychology is the lowest (21%)
- The response rate of H papers seems to be higher than or at least equal to the response rate in N papers in almost all fields.
  - Exception is the computer science & mathematics (3% higher for the N papers)

Young Authors

- Any author (Japan/US)
  - Post-doc
  - PhD student
  - MA/undergrat
- First author (Japan/US)
- By field, top v. other (Japan/US)

Author composition, all authors, Higher education institutions, US (natural sciences)



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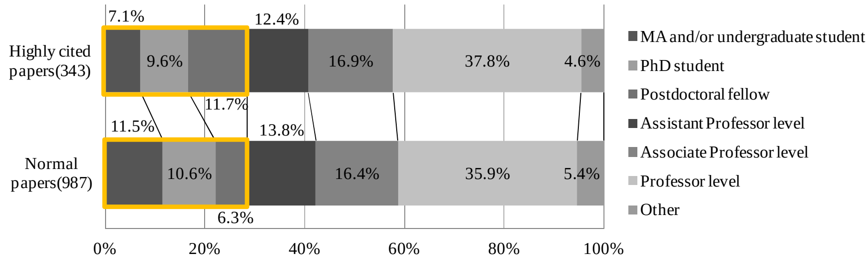

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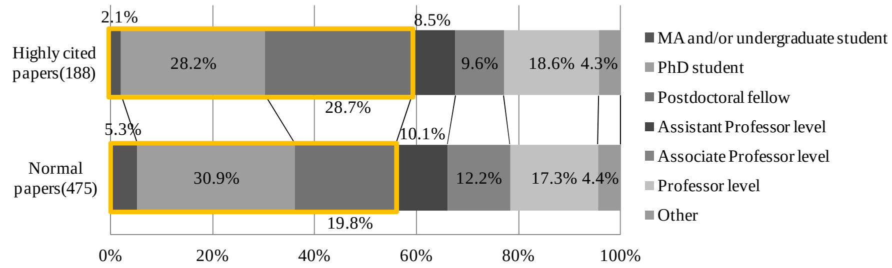

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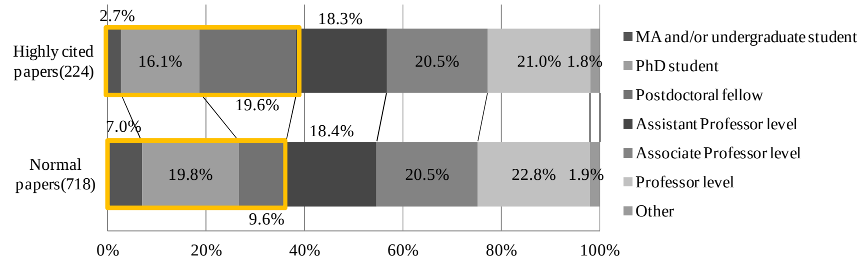

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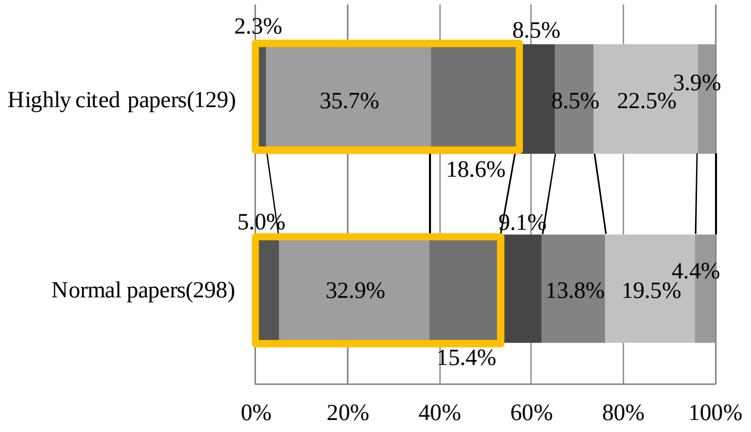

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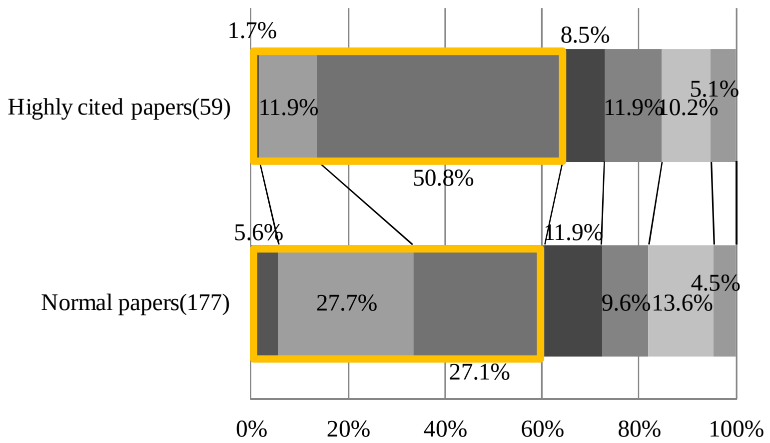

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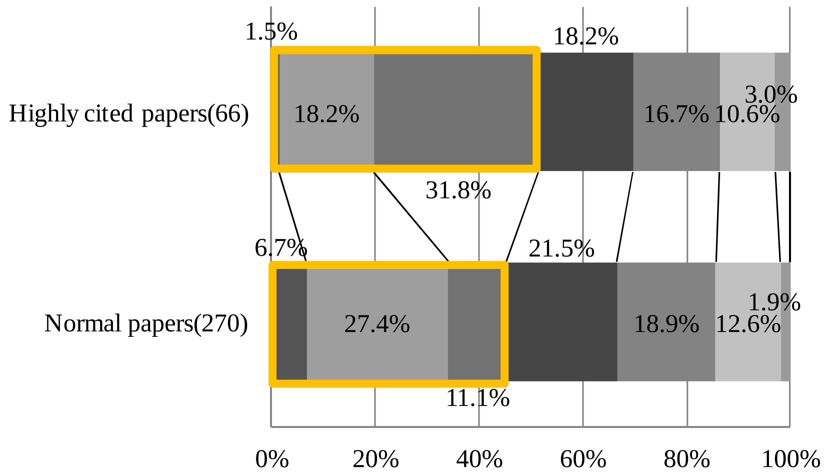

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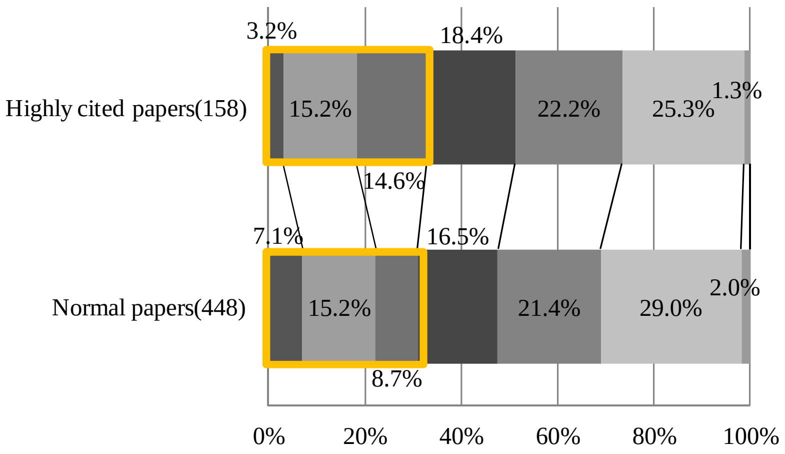


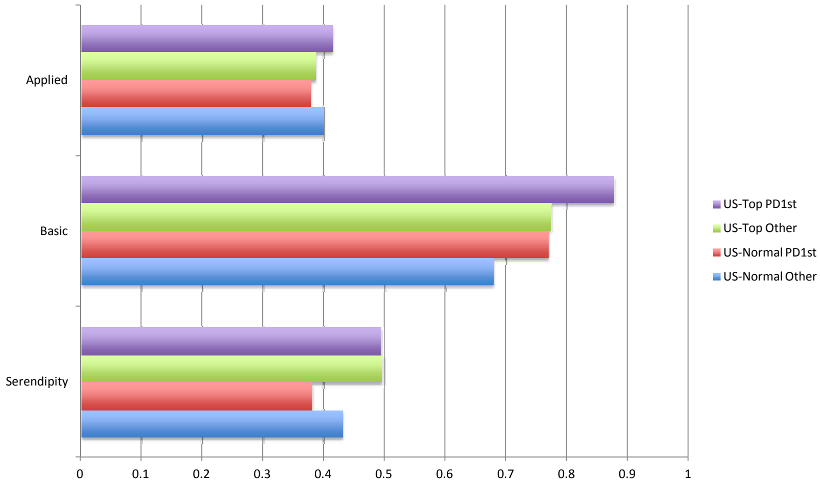
Findings

- Young researchers make up a significant share of authors, and disproportionate share of first authors
- In life science top papers in the US, post-doctoral researchers dominate (over half)
  - Over 30% in Japan as well
- Post-doctoral researchers are key to life science laboratories
  - However, may reflect labor surplus as these may be frustrated aspirants to assistant professor roles

Project Types

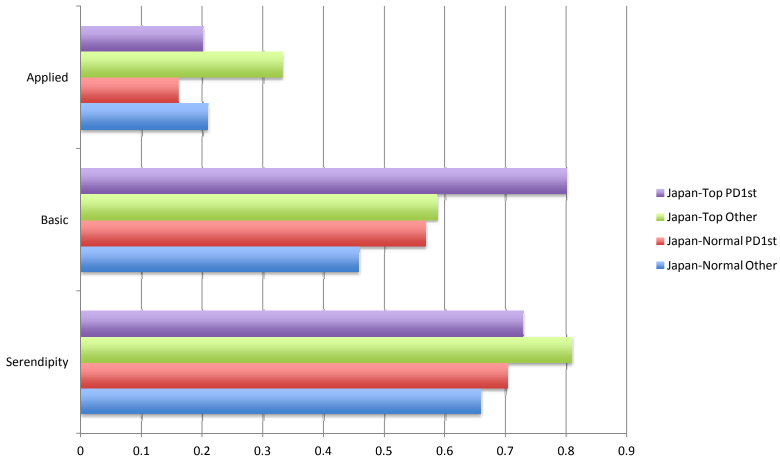
- Do PD projects specialize in basic, applied, Pasteur’s quadrant?
- And, are they more (or less) likely to generate serendipitous findings

Project Types, by post-doc papers, top, US



Note: difference in **basic**, top and normal, significant (.05)

Project Types, by post-doc papers, top, Japan

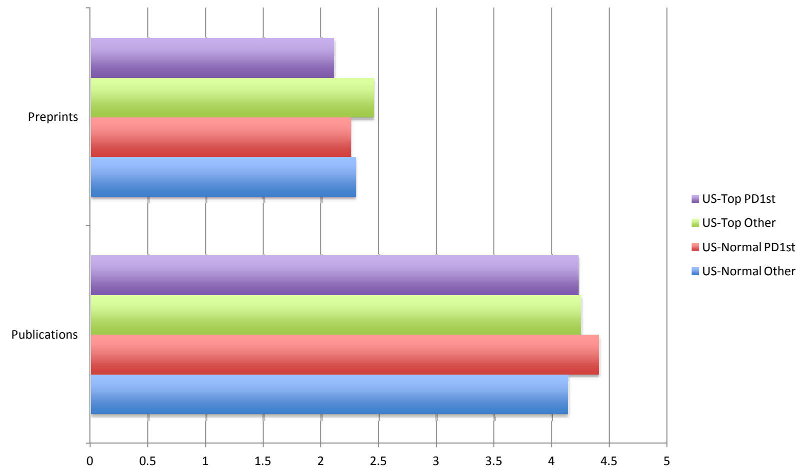


Note: difference in **basic**, top and normal, significant (.05), and in **applied**, top, sig, (.05).

Knowledge

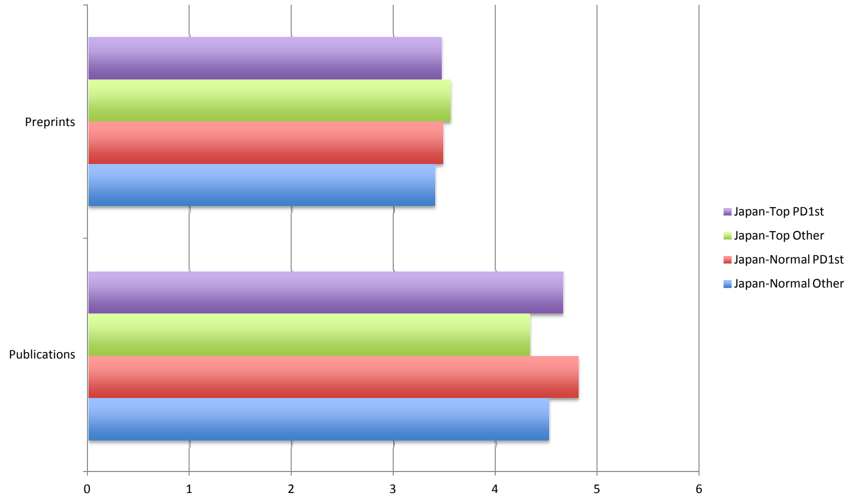
- Are young researchers key to bringing new knowledge into the lab (Vogel, 1999)?
- Measures of uses of outside knowledge
  - Access current published literature
  - Access pre-print literature
- Compare young author papers to others

Knowledge Sources, by post-doc papers, top, US



Note: difference for **publication**, normal significant (.05)
Difference in **preprints**, top significant (.05)

Knowledge Sources, by post-doc papers, top, Japan



Note: difference for **publication**, significant for top (.10), normal (.05)

Findings

- We find that post-doc papers are more likely to be focused on fundamental principles/understanding (basic), somewhat less likely to focus on solving practical problems
- We also find that Top post-doc papers in the US are more likely to result in a patent application (21% v. 11%, p<.05), though not in Japan
- We find some evidence that post-doc papers are more likely to access outside knowledge from publications (post-docs may be more current on literature, or more active in reading recent publications)
- May be somewhat less plugged in to preprint literature (weak evidence, with only US top as significant

Post-docs and Project Performance

- Are post-doc's papers more likely to produce top quality papers?
- And, does this vary by context (field, country)?
- Important for understanding contribution of post-docs to science system
- Regress "top" paper on post-doc first author, controlling for project size, industry ties, basic, field.
  - Field-specific regressions (life v. physical)

Logistic regression of top paper on post-doc first author

		US			JAPAN	
	ALL (field dummies)	LIFE	PHYSICAL	ALL (field dummies)	LIFE	PHYSICAL
Post-doc 1st	.64*** (.20)	.88*** (.27)	12 (.32)	.84*** (.21)	.92*** (.32)	.46 (.31)
Authors	.23*** (.03)	.26*** (.04)	.19 (.04)	.16*** (.04)	.25*** (.03)	.08* (.04)
Ln(months)	-.05 (.09)	-.10 (.12)	-.08 (.12)	-.01) (.07)	.18 (.12)	-.14* (.08)
Funds/100K	.01** (.00)	.01*** (.00)	-.00 (.00)	.02*** (.00)	.01* (.01)	.02*** (.01)
Industry funds	-.73** (.32)	-.55 (.43)	-.89* (.50)	.07 (.17)	.00 (.27)	.08 (.23)
Company co-author	-.26 (.42)	-1.33 (.81)	/39 (.47)	-.02 (.26)	.43 (.41)	-.01 (.34)
Basic	.72*** (.22)	.49* (.30)	.78** (.31)	.59*** (.17)	.68** (.26)	.33 (.20)
N	732	369	363	1089	501	588
Chi-sq	91.2	55.3	27.3	80.6	81.0	22.0

Predicting top papers

- Post-doc papers (first author) are more likely to be top papers
  - In US and Japan
- However, this is only the case in life sciences, not physical sciences, engineering
  - Results largely robust if do detailed field by field analyses
- Related to organization of labs in different fields? Labor market?
  - For example, large biology labs may be organized as loosely coupled decentralized projects (subcontracting?) while in physical sciences, labs may be organized in a more integrated, centralized project (Vogel, 1999; Swatez)

Conclusions

- Young researchers make up a significant share of authors, including first authors
- Post-doc authored papers more likely to be top quality
- But, this effect largely limited to bio-medical fields
- Next questions: drivers of composition?
  - Equipment needs as driver of team composition?
- Explanation of differential impact of PD across fields (and within fields)
  - Centralized/decentralized?
  - Interdependence?
  - Heterogeneity?