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Commercializing Academic Science in a Changing Policy Environment: A Natural Experiment

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Increasing engagement of universities with commercial activity

- Calls for science that is more engaged in society
  - Pasteur's quadrant, mode 2
- Competitiveness agenda
  - Economic development as mission (Slaughter and Rhoades, 1996; Glenna, et al., 2007)
- Substantial evidence of increasing commercialization of science (Nagaoka, et al., 2009)

Tech Transfer Policy and Commercialization Outcomes

- Significant debate about the best way to organize technology transfer
- Begins with US Bayh-Dole Act, that gives universities control over federally funded technologies.
- This led to a global debate about ideal technology transfer policy, in particular, whether it was better for professor or university to own the inventions.
- Various countries shifted their institutional structures to mimic the US, giving the university control rather than the professor (Guena and Rossi, 2011)
  - Denmark (2000), Germany (2002)
  - But Italy (2001) switched in the other direction.

Tech Transfer Policy and Commercialization Outcomes-conflicting arguments

- University ownership:
  - scale economies and advantages of division of labor (professors do science; TLOs patent and license)
  - TLOs may have broader networks with firms
- Professor ownership:
  - may have close ties with company researchers in their field, often with ongoing collaborations or sponsorship agreements.
  - may have better insights into the potential, and limitations, of the technology and so may be better positioned to help develop its commercial applications
  - May have lower transaction costs (gift exchange)
- Empirical evidence limited (Kenney and Patton, 2009; Geuna and Ross, 2011)

Tech Transfer Policy and Commercialization Outcomes-evidence

- Breznitz (2011) finds that after Cambridge centralized control over IP, there was a decline in its technology transfer activity.
- Carraz (2011) shows that patenting by faculty at Tohoku University increased slightly after the shift from professor to university ownership, although the percent assigned to firms dropped and the percent assigned to universities increased, suggesting more of a change in composition of the forms of technology transfer than in overall commercial activity.
- Kenney and Patton (2011) find professor ownership is associated with higher rates of university spin-offs.

Tech Transfer Policy and Commercialization Outcomes-evidence

- Valentin and Jensen (2007) compare university-based inventors in Sweden and Denmark on biotech firm's patents (a measure of professor participation in commercial activity) and find that the change in ownership regime (from professor to university) was associated with a decline in Danish university co-inventors on biotech firm's patents (compared to Sweden), suggesting that professor ownership may be better for technology transfer.
- Kenney and Patton (2009) review several cases from the US, Japan and Europe and find little evidence that TLO ownership increased technology transfer (though it also did not clearly decrease it).

Pre-Reform Japanese Tech Transfer Regime

- Most research in Japan is conducted in national universities
  - Faculty were civil service; severely restricted in their outside activities
  - Formalized U-I linkages, especially consulting, being actively involved in start-ups or scientific advisory boards, or university-owned patents being licensed to firms, were all largely prohibited or rare practices
- But, common for company R&D managers to make donations to professor's labs, to send researchers
- Not absolute professor privilege (ownership depended on details of project funding)
  - In practice, over 90% of inventions ended up being assigned to the professor
- If professors developed patentable technologies, they generally assign patent rights to a partner firm (rather than the university): gift exchange

Policy Shift in Japan

- 1990s recession (Lost Decade), Japanese policy makers began to emphasize universities as a source of innovation and economic growth.
- Perceived US success was attributable to substantial federal support for university research, close university-industry links, and strong protection of intellectual property rights (IPRs).

Policy Shift in Japan

- Japan revised S&T policy using the US system as a model:
  - Science and Technology Basic Law revised (1995 and subsequent years) to commit to a major increase in public research funding
  - The Technology Transfer Law (1998) enabled the establishment of TLOs and allowed universities to claim rights in publicly-funded inventions.
  - The Japanese Bayh–Dole Act (1999) permitted industry to retain property rights derived from publicly funded research.
  - Strengthened patent rights, which encouraged university patenting
  - Personnel reforms (from 1997) allowing professors to be managers of startup companies, serve on SABs and do paid consulting.
  - Hiranuma Plan (2001) to generate 1000 university startups. This goal was reached in three years.
- Result was by early 2000s, Japan had institutionalized academic entrepreneurship regime

Policy Shift in Japan: A Natural Experiment

- National universities incorporated (2004)
  - Toyama plan, Exogenous shock—Goal was downsizing government; part of Koizumi liberalization reforms (cf. postal reform)
- Led to a variety of changes,
  - Revoking the professor privilege (making Japan more similar to the US)
  - Establishment of IP headquarters in universities (replacing TLOs)
  - Giving universities more budget autonomy to encourage them to seek industry funding
- Given significant levels of academic entrepreneurship before incorporation (on par with US on most measures), change provides natural experiment
  - US as a control to rule out many technological opportunity explanations

Research Questions

- What are the project-level commercialization rates (patents, licenses, startups), across countries, fields?
- Does the US-Japan gap change after incorporation in Japan (and in which direction)?
- Is there a shift in composition of projects (more use oriented, more industry funding)?

US-Japan Scientists Survey

- Select a publication and use that as focus object for collecting information on inputs to and outcomes of a research project
- Articles and letters in Science Citation Indexes-Expanded (Thomson Reuters)
- Time window: 2001 – 2006 (database year)
- Sampled about 9000 papers, in each country
  - Stratified by field
  - 1/3 from top 1% in citations (High), and 2/3 from rest of population (Normal)

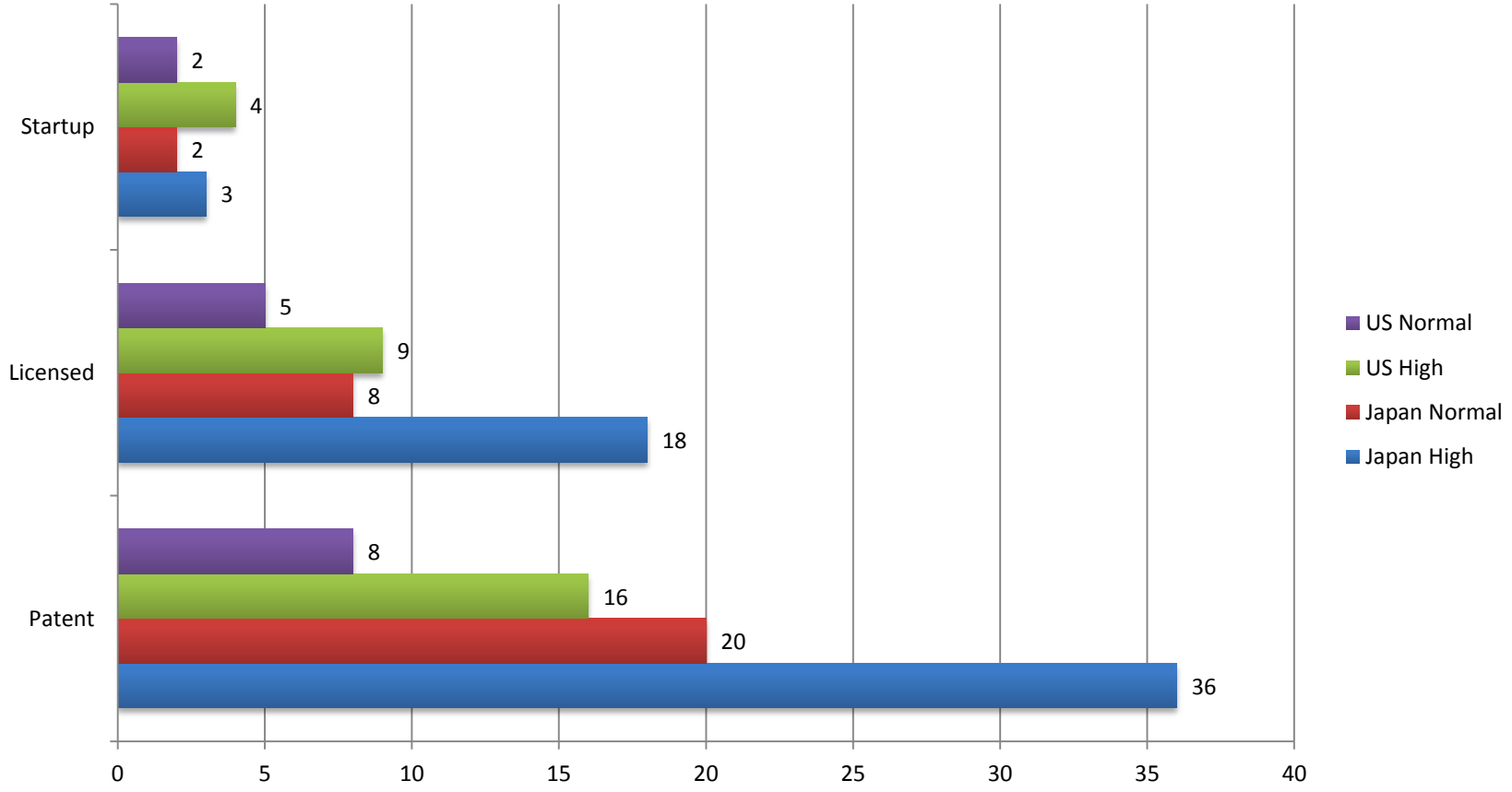
Survey timeline and response rates

- Japan (winter-spring, 2009-2010): 7652 mailouts; 2081 responses (27% response rate)
- US (fall-winter, 2010-2011): 8864 mailouts; 2327 responses (26% response rate)
  - Below average response rates in clinical medicine and related
  - 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
- For this analysis, we limit responses to those in universities and hospitals and exclude social science (US=1480; JP=1541). Use field weights when calculating country means to control for composition differences.
- For DD analyses, exclude 2003-2004 cohorts because of endogeneity (ability to speed up or slow down project to end up under one regime or the other, Kneller).

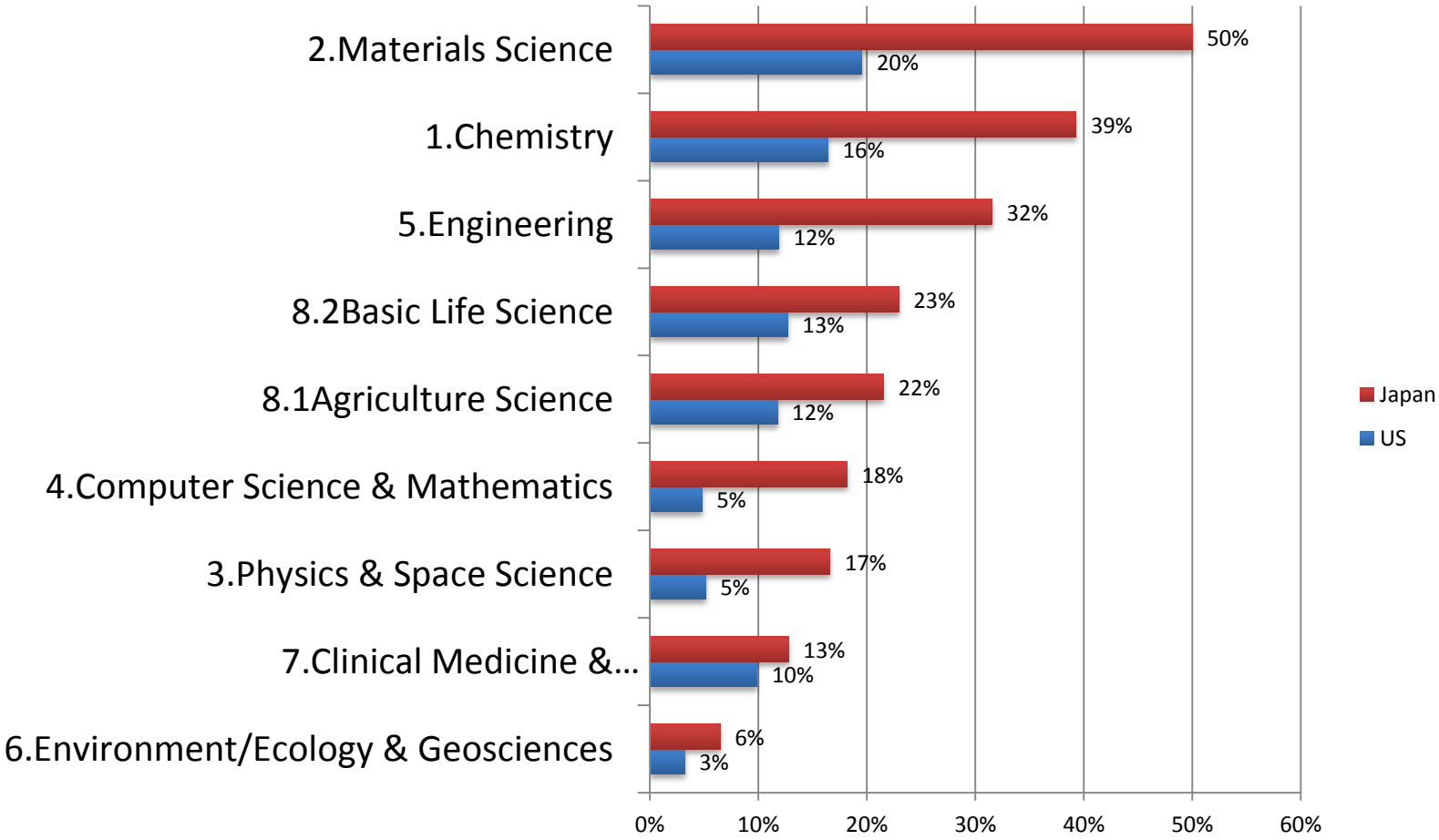
Commercial Activity

- Patents
- Licensing
- Startups

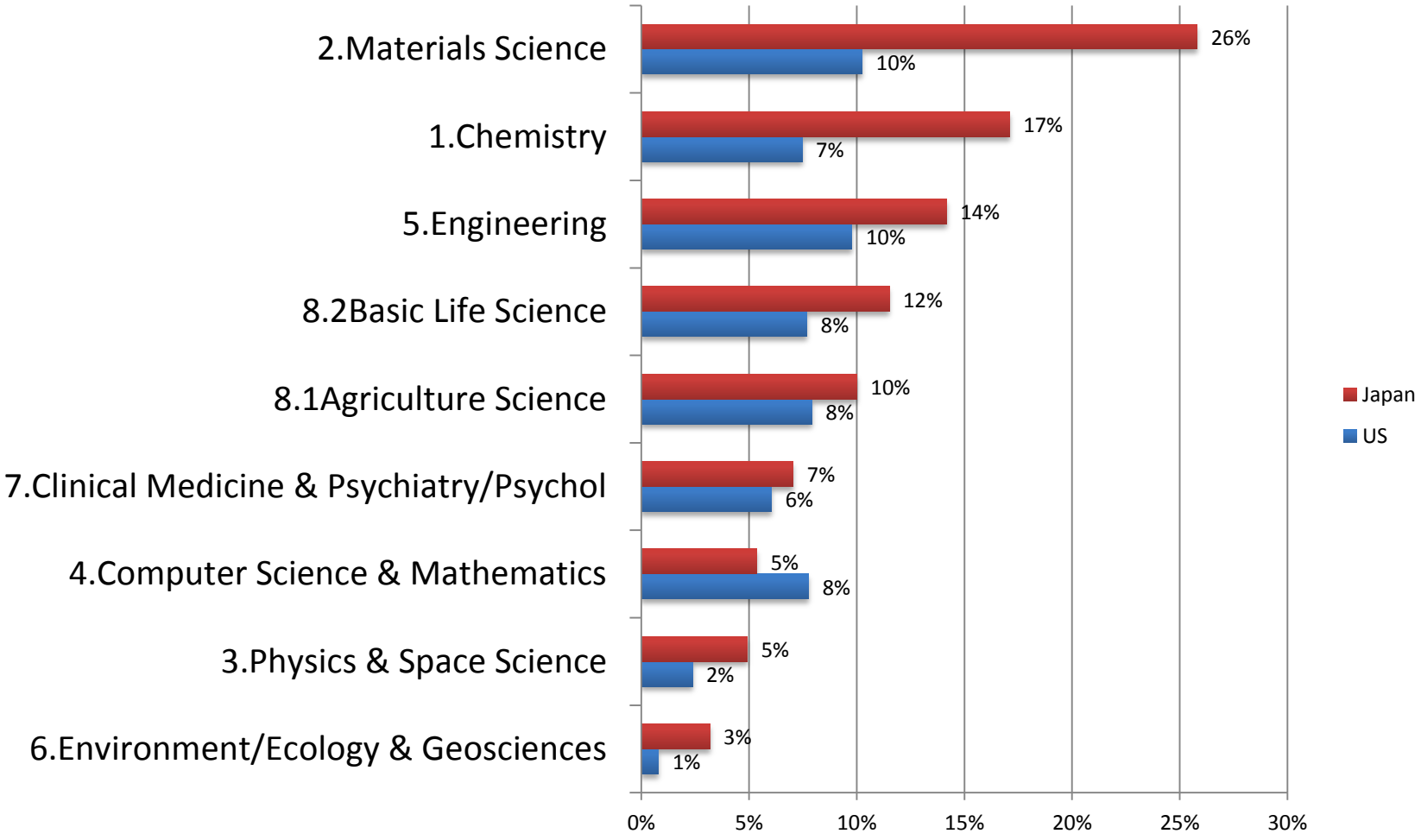
Project-Level Commercial Activity, Japan and US, field weighted



Patents, Japan and US, by field



Licensed, Japan and US, by field



Commercial Activity

- Japan generally higher than US (patent, license), though not for startup
  - Startups fairly rare (on project basis)
- Highly cited papers more often commercialized
- 51% of Japanese patents include foreign application (60% for highly cited papers) v. 21% in US
- Majority (65% in US, 76% in Japan) of licenses include providing know how (Thursby and Thursby 1999).

Natural Experiment: Policy change and commercial activity

- Compare rates of patents and licenses in Japan (versus US), and differences after incorporation (Diff-in-diff model)
  - Overall and net of project characteristics
- Change in composition of research (more "use" oriented)? (Thursby and Thursby, 2011)

Changes in Commercial Activity, Japan and US

	Japan			US			
	01-02	05-06	Diff	01-02	05-06	Diff	Diff-in-diff
Patent App (%)	23.2	23.9	0.7	12.6	8.8	-3.8	4.5
License (%)	12.3	9.7	-2.6	8.8	3.9	-4.9	2.3
Internat App (%)	13.2	11.3	-2.1	2.2	2.7	0.5	-2.6

Logistic Regression Predicting Patenting, Japan Only

	Patent application		
	Model 1	Model 2	Model 3
After	.042	.352*	.341Δ
	(.152)	(.174)	(.192)
Field	No	Yes	Yes
Size	No	Yes	Yes
Use/Industry Links	No	No	Yes

Logistic Regression Predicting Licensing, Japan Only

	License		
	Model 1	Model 2	Model 3
After	-.263	-.020	-.233
	(.232)	(.254)	(.281)
Field	No	Yes	Yes
Size	No	Yes	Yes
Use/Industry Links	No	No	Yes

Logistic Regression Predicting International Patent Application, Japan Only

	International Application		
	Model 1	Model 2	Model 3
After	-.176	.179	.094
	(.198)	(.225)	(.249)
Field	No	Yes	Yes
Size	No	Yes	Yes
Use/Industry Links	No	No	Yes

Ordered-Logit Regression Predicting Use Oriented Research, Japan Only

	International Application		
	Model 1	Model 2	
After	.130	.198	
	(.115)	(.120)	
Field	No	Yes	
Size	No	Yes	

Logistic Regression Predicting Any Industry Funding, Japan Only

	International Application		
	Model 1	Model 2	
After	-.180	-.114	
	(.149)	(.158)	
Field	No	Yes	
Size	No	Yes	

Changes in Commercial Activity in Japan after Regime Change

- For Japan, after the change (from professor ownership to university ownership) patent application rates increase (on a per project basis), controlling for composition
- No change in licensing, or in international patenting.
- We also find that more authors associated with less commercialization
- While project size and more citations associated with more commercialization
- As is use oriented research, industry funding and industry co-authors (though last only sig for patent apps)
- And, no evidence of shift in composition (though increase in use oriented is almost significant controlling for size)
- But, how does this compare to contemporary changes in US (control group)?

DD Logistic Regression Predicting Patenting

	Patent application		
	Model 1	Model 2	Model 3
Japan	.742***	.509 *	.627**
	(.176)	(.205)	(.221)
After	-.404 Δ	-.151	-.150
	(.214)	(.242)	(.267)
JP*After	.446 Δ	.499 Δ	.487
	(.263)	(.289)	(.318)
Field	No	Yes	Yes
Size	No	Yes	Yes
Use/Industry Links	No	No	Yes

DD Logistic Regression Predicting Licensing

	License		
	Model 1	Model 2	Model 3
Japan	.381 Δ	.107	.219
	(.226)	(.275)	(.294)
After	-.854**	-.698*	-.641Δ
	(.292)	(.317)	(.343)
JP*After	.591	.652 Δ	.426
	(.373)	(.394)	(.431)
Field	No	Yes	Yes
Size	No	Yes	Yes
Use/Industry Links	No	No	Yes

DD Logistic Regression Predicting International Patenting

	International patent application		
	Model 1	Model 2	Model 3
Japan	1.928 ***	2.006 ***	2.096***
	(.346)	(.368)	(.375)
After	.229	.484	.435
	(.426)	(.470)	(.495)
JP*After	-.405	-.316	-.344
	(.469)	(.514)	(.549)
Field	No	Yes	Yes
Size	No	Yes	Yes
Use/Industry Links	No	No	Yes

DD Ordered-Logit Regression Predicting Use-Oriented Research

	Use-Oriented Research		
	Model 1	Model 2	
Japan	-.381**	-.513***	
	(.121)	(.134)	
After	.136	.097	
	(.132)	(.140)	
JP*After	-.019	.068	
	(.167)	(.174)	
Field	No	Yes	
Size	No	Yes	

DD Logistic Regression Predicting Any Industry Funding

	Any Industry Funding		
	Model 1	Model 2	
Japan	-.843***	.566**	
	(.175)	(.200)	
After	-.361Δ	-.490*	
	(.213)	(.234)	
JP*After	.181	.341	
	(.260)	(.277)	
Field	No	Yes	
Size	No	Yes	

Results

- Policy shift in Japan (from professor to university ownership) associated with relatively higher levels of patenting and licensing (compared to pre-reform Japan and compared to US), although effects are modest
- No evidence of a greater shift toward use-oriented research, or toward industry funding

Conclusions

- Commercial activity higher in Japan (except for startups)
- Also, (in both) generally higher in materials science, chemistry and engineering
- Policy shift in Japan (from professor to university ownership) associated with somewhat increased levels of patenting and licensing (compared to pre and to US), although effects are modest
- Suggesting there may be advantages to university-ownership/formalized technology transfer over professor privilege/informal
  - But, no increase (even decrease?) in international patenting, suggesting impact might be limited (or even symbolic?)
- Still need to develop understanding of mechanisms that might drive such a result:
  - Network advantages
  - DoL/Specialization
  - Incentives

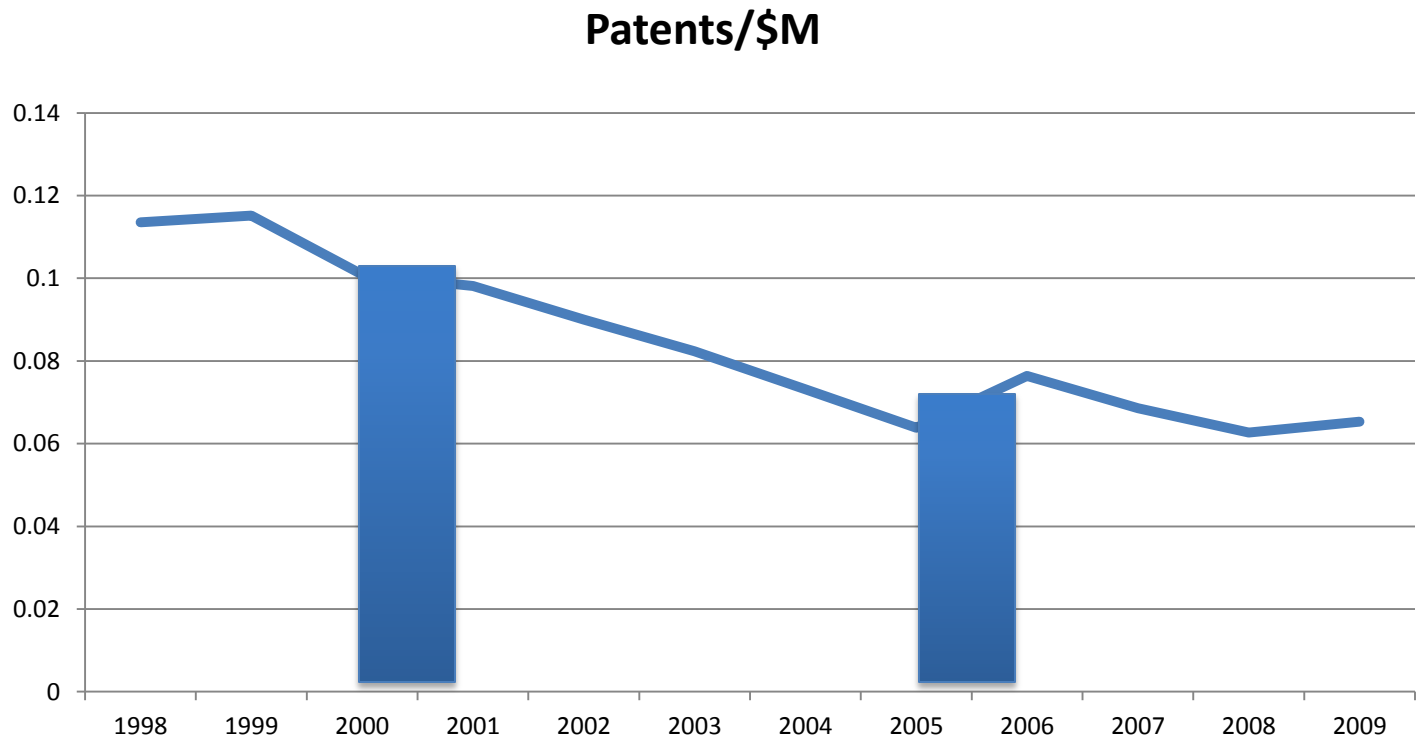
Appendix Slides

Changes in Commercial Activity, Japan and US

Variable	US		JP	
	Before	After	Before	After
Patent_app (%)	12.6 [33.2]	8.75 [28.3]	23.2 [42.2]	23.9 [42.7]
License (%)	8.75 [28.3]	3.92 [19.4]	12.3 [32.9]	9.74 [29.7]
International pat. App (%)	2.2 [14.6]	2.7 [16.2]	13.2 [33.9]	11.3 [31.7]
Use oriented research (1-5)	3.57 [1.42]	3.67 [1.38]	3.33 [1.34]	3.44 [1.25]
Some DOE funds (%)	4.26 [20.2]	5.23 [22.3]	3.92 [19.4]	5.32 [22.5]
Some DOD/JST funds (%)	9.00 [28.6]	7.27 [26.0]	10.9 [31.2]	13.6 [34.3]
Any industry funding (%)	13.7 [34.5]	10.0 [30.0]	27.0 [44.4]	23.6 [42.5]
Any firm co-author (%)	7.00 [25.5]	3.84 [19.2]	6.90 [25.4]	8.61 [28.1]
Number of authors	4.68 [3.50]	5.10 [4.34]	6.01 [13.3]	6.80 [13.4]
Ln(man-months)	3.42 [1.36]	3.37 [1.14]	4.44 [1.40]	4.38 [1.28]
Funds	9.23 [27.8]	9.78 [30.0]	7.97 [24.7]	6.77 [20.4]

Note: for 2001, 2002, 2005, and 2006 cohorts of publications. Numbers in brackets are standard deviations.

Decline in US academic patenting rate, 1998-2009



Source: NSF, Science and Engineering Indicators, Appendix Tables 05-46 and 05-02, constant 2006 dollars.