Characterizing Receiver-Active National System of Innovation

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- W. G. Morin (US co-chair)
- F. Kodama (Japan co-chair)

RAP

“Receiver-Active Paradigm”

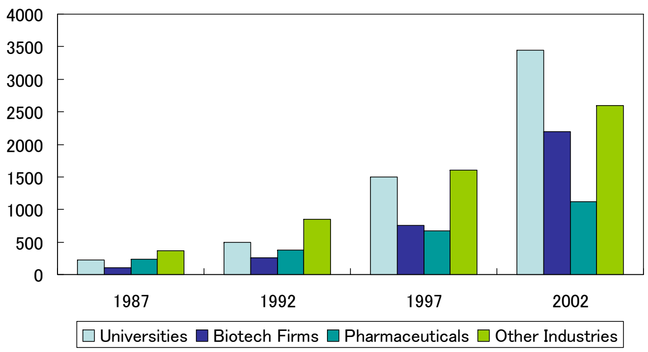
- This model holds that successful technology transfer is largely dependent on the receiver rather than the sender.
- Aggressive receivers can obtain technology from passive senders,
  - but
- passive receivers are unlikely to obtain technology from even the most aggressive senders.

Mowery and Nelson suggests that

- the most significant change in the content of the university research in the United States has been the rise of
  - biomedical research
- and inventive activity.
- The rise in biomedical research and the growth of its associated inventions
  - predate
- the passage of Bayh-Dole in major universities.

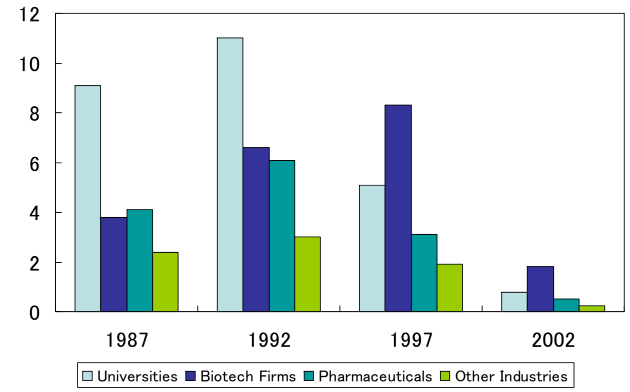
Patent Applications in Biotechnology (in USA)

Source: compiled by Nagaoka & Ohnishi based on CHI data



Average Number of Citations per Patent (in USA)

Source: compiled by Nagaoka & Ohnishi based on CHI data



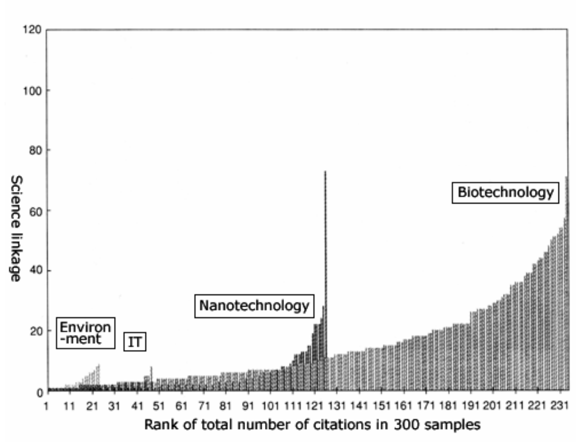
How the biomedical research is different

- from other fields of sciences, in terms of university-industry linkages.
- We will describe our measurement results of science linkage based on the Japanese patent data base, and
- show that biotechnology is extremely high in science linkage
  - (number of scientific papers cited in patent),
- compared to other fields of science.

Extracting samples by random sampling

- Japanese government‘s “Second Science and Technology Basic Plan” designated as priority areas:
- biotechnology; information technology; nanotechnology and; environmental technology
- We extracted 300 patents from each category and 300 patents from the entire patent set (regardless of sector) for comparison purposes via random sampling.
- In other words, a total of 300・5 (the four priority categories + all categories) = 1,500 patents were included in the sample.

Number of science citations per patent by rank

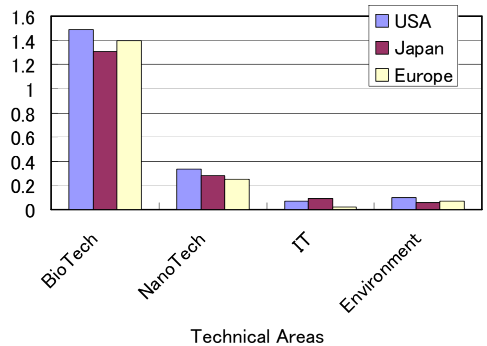


Science Linkage by Technical Areas

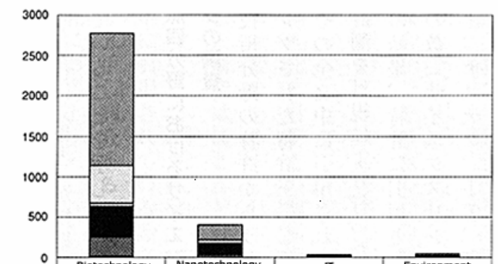
Area	cited papers total	cited papers per patent	cited patents total	cited patents per patent
· Random Ample	179	0.6	1,749	5.83
· Biotechnology	3,439	11.46	1,102	3.67
· Nano-technology	597	1.99	2,125	7.08
· IT	95	0.32	927	3.09
· Environment	77	0.26	1,193	3.98

International Comparison of Science Linkage

Average Number of Cited Papers per Claim per Patent



Type of institutions with which authoring researchers are affiliated



	Biotechnology	Nanotechnology	IT	Environment
Universities	1636	190	12	22
National research institutes	473	38	0	12
Other public research institutes	40	14	4	1
Corporations	366	130	18	8
Individuals	10	2	1	0
Others	242	30	1	0
Unidentified	10	0	0	0

Cohen and Levinthal (1990) introduced the term

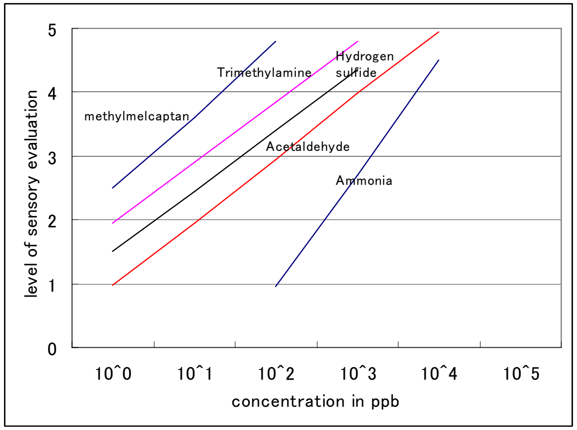
“Absorptive Capacity” of a firm,

- “an ability to recognize the value of new information, assimilate it, and apply it to commercial ends.”
- A Japanese sanitary ware company, could commercialize a toilet system in which the organic compounds are decomposed bio-chemically, therefore, instantly.
- In 2004, the Nobel Prize in Physiology or Medicine was awarded to those scientists who established the new sciences around the olfactory receptors in their landmark paper published as recently as in 1991.

"Honda-Fujishima effect" photo-catalytic properties of titanium oxide

- *Nature* (1972): Fujishima, A. and Honda, K. (The University of Tokyo), hydrogen production for the energy crisis
- *Nature* (1980): Kawai, T. & Sakata, T. (National Institute of Molecular Sciences), efficient oxidizers of organic matter
- Nature (1997): Wang, R., Hashimoto, K., Fujishima, A. (Univ. of Tokyo), Chikuni, Kojima, Kitamura, Shimohigoshi, Watanabe (TOTO), photo-induced *super-hydrophilic* property

A synthesizer of bad smells built in 1978



The researchers in TOTO gathered air samples and successfully synthesized the smells

Odorant		Hospital room	Toilette	Urine	Stool	Sweat
Nitrogenous family	Ammonia	0	0	0		0
	Trimethylamine	0	0	0		
Sulfurous family	Hydrogen sulfide	0	0		0	
	Methylmercaptan	0	0		0	
Organic family	Acetaldehyde	0				
	Acetic acid	0				0

*Data from TOTO website

The continuing collaborative research

- furthermore, discovered photo-induced *super-hydrophilic* property.
- This property is not the part of photo-redox reaction, but is more important for the *self cleaning* effect of titanium dioxide coated tile as it contributes for rinsing chemical compounds away.
- Without super-hydrophilic property, the practical application of photo-catalytic titanium dioxide could not have achieved as we see today.
- exterior ceramic tiles (in 1996); sophisticated active deodorizer (in 2001).

U.S. studies suggest that

- academic research rarely produces “prototypes” of inventions for development and commercialization by industry
- instead, academic research informs the methods and disciplines employed by firms in their R&D facilities.
- The channels rated by industrial R&D managers as most important rarely include patents and licenses.

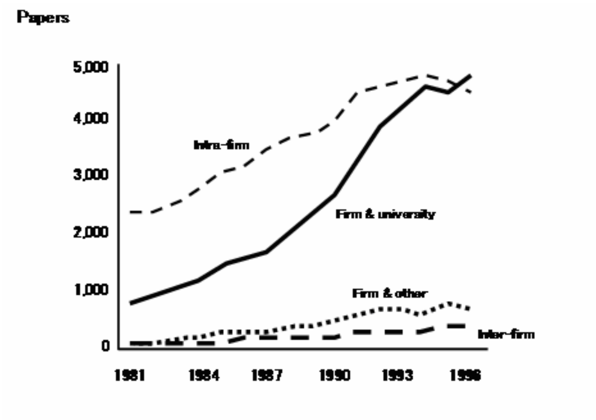
A Macro Study of National Innovation System

- frame the macro description around the receiver-active paradigm. What are the most appropriate measures of university-industry linkage, which accommodate the receiver-active paradigm?
- The number of TLOs at universities, are obviously not appropriate: the idea is reflection the sender-active paradigm; university active in marketing of their research outputs.
- Agrawal and Henderson made a study of papers written by and patents awarded to MIT professors, and conclude that patenting is not a “substitute” of writing papers.

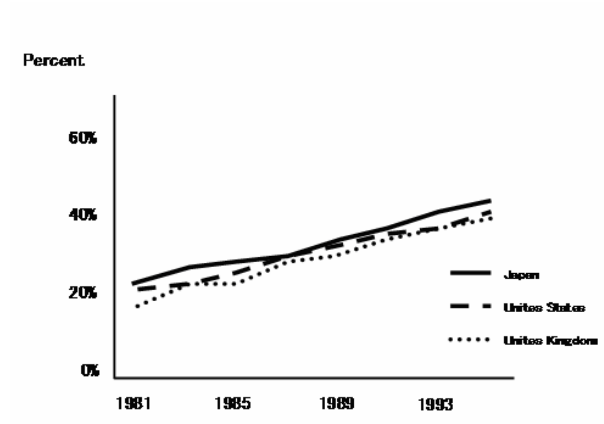
Analyzed co-authorship between university and industry from the perspective of industry.

- We chose a 16-year period, 1981-1996, for our study.
- Searching a database from the Institute of Scientific Information of publications in which at least one author is affiliated with an organization located in Japan,
- we created a subset containing all papers in the database published with at least one author from a firm located in Japan.
- This subset contains 110,588 papers.

Japanese Industry Papers by Mode of Collaboration



Co-authorship in the United Kingdom, the United States and Japan



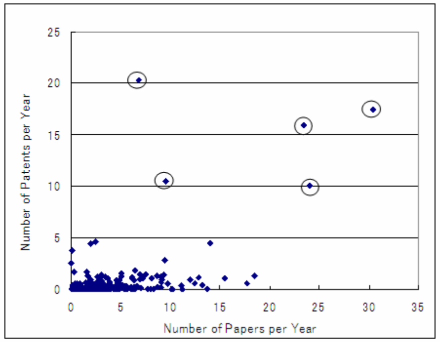
Complimentary Relation between Co-Authorship and Co-Invention

- Over the past 10 years, we have collected data on papers and patents published by engineering professors at the University of Tokyo and could make a comparison with the corresponding data on MIT professors.
- In total, 392 professors who were registered during 1991-2002 are investigated. Out of this total, 83 professors are those of mechanical and electrical engineering.
- We purchased Institutional Citation Report from Thomson Scientific Inc., and counted the number of papers published by individual professors and the number of citation to these papers every year from 1992 to 2001. We also compiled the co-authors for each paper.

As for patent database,

- we used the patent publication by Japanese patent office. Inventors and applicants are matched with the names of 392 professors with their address. Thus, we could retrieve 2,115 patents during the 10 years.
- This number should be compared with 186 patents that are registered by the University of Tokyo.
- It becomes clear that the patents registered officially by the University of Tokyo compose only 10 percent of patents which are invented by UT professors.

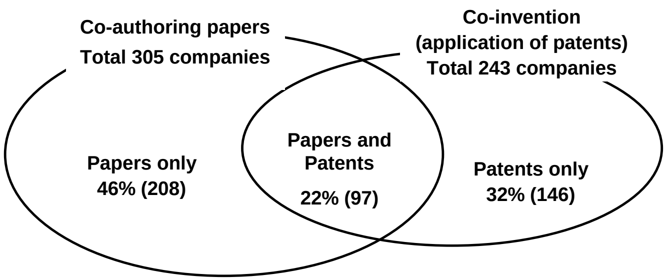
Scattered diagram of the number of papers and patents



No significant causality between papers and patents

- A positive correlation between the number of patents and that of papers?
- However, those five professors who are extremely high both at papers and patents give a substantial influence on total landscape.
- By excluding those five irregular points from regression analysis, no significant causality is found out.

How Professors and Companies are Collaborating?



* The unit of analysis is company (total 451)

22% of collaborations being with both co-authorship and patent

- In the case of MIT professors, only 3% of collaborations are with both co-authorship and patents.
- This indicates that Japanese companies do not obtain licensing from universities unilaterally but are developing *absorptive capacity* by sending employees to university labs and through joint research with university professors.
- TLOs might dilute the informal collaborations which existed and worked well so far.

How the receiver-active paradigm works?

- By collaboration through co-authorship, the process of technology transfer is initiated and the two parties can share the common understanding how the scientific discoveries are to be transformed into useful technologies.
- Only after these mutual understanding is accomplished, they go to patent applications.
- In other words, without joint collaboration in research, companies cannot be active in understanding and receiving the university research.

Concluding Remarks

- Receiver-Active Paradigm in Japan suggests that National Innovation System which stimulates Absorptive Capacity functions effectively.
- Kneller (2003) pointed out that although informal technology transfer between universities and private sector in Japan looks more efficient than formal one,
- there exist some problems such as de facto preferential treatment to the large firms, disincentive to firms for farther development caused from unclear IP (Intellectual Property) rights and so on.

What are the implications to Asian universities as drivers of the urban economies?

- receiver-active versus sender-active system:
- The effectiveness of these two systems dependent on the following items:
- industrial structure in terms of resource-based or manufacturing-based economy, software-based or hardware-based industry;
- industrial management, in terms of scientists-dominated or engineers-dominated technology development, top-down style or bottom-up style of decision-making;
- and, perhaps societal/academic structure, in terms of egalitarianism or achievement-based mobility.