

Science linkages in technologies in Japan

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Motivation of our study

- How is the relationship between science and technology? Is it different from technology to technology?
- How is the impact on innovation of government's support for scientific activities?



Purpose of our study (1)

- That science serves as the engine of technological change and economic growth is widely recognized.
- Mansfield pointed out that the development of 10% of new products and process could not have been developed without substantial delay in the absence of recent academic research (Mansfield, 1991).
- As more attention has been focused on science as the source of technological change that would lead to economic growth, there has also been increased interest in the linkage between science and technological change (Narin *et al.*, 1997).

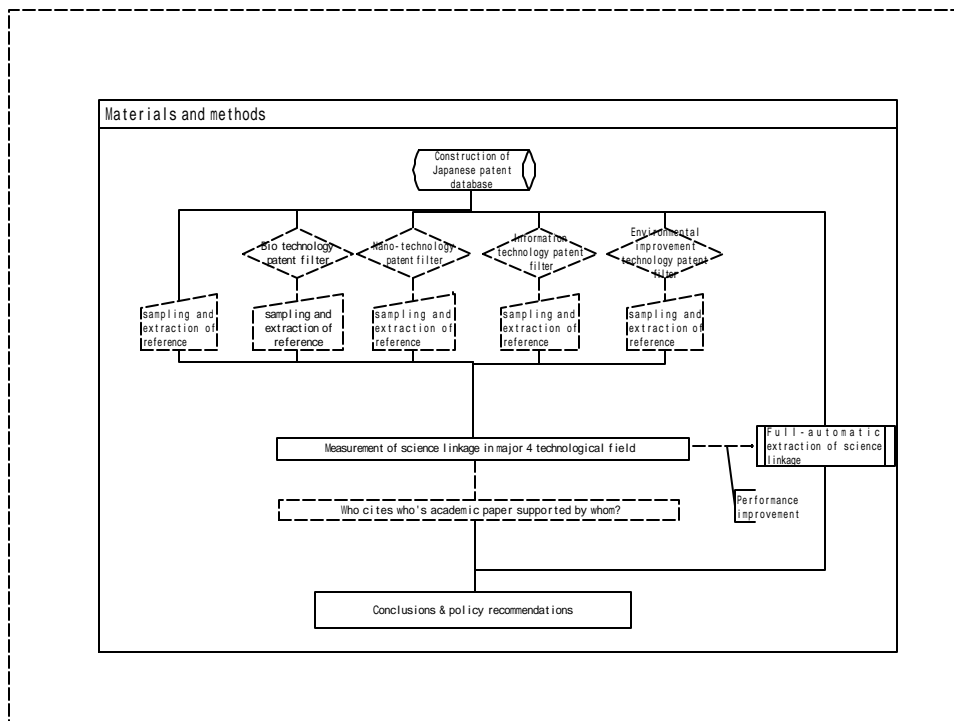


Purpose of our study (2)

- In recent years, the “Science Linkage,” which indicates the number of non patent reference, that are mainly academic papers, cited per patent, has been used as an indicator for understanding the effect that science exerts on technology
- But no study of science linkage in Japanese patent was found

Research questions

- Do inventors cite academic papers in Japanese patents? If so, is the science linkage differ from technology to technology?
- Who cites who's academic paper supported by whom?
- Is the distribution pattern of science linkage among various technological classification in Japanese patent different from that in the EU?



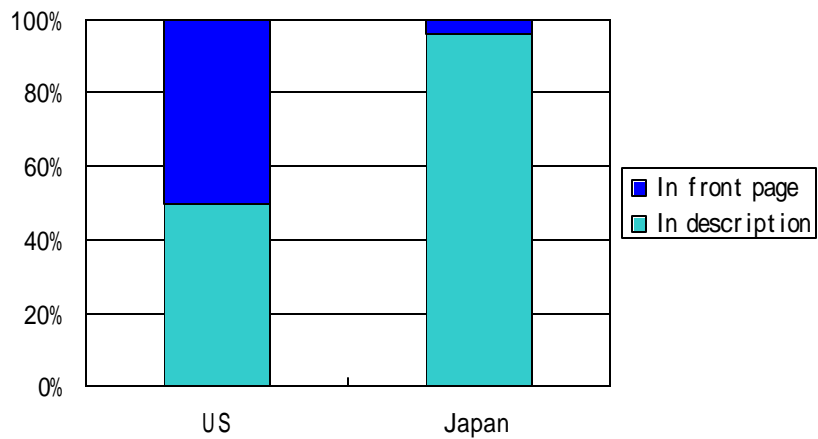


Constructing original database

- Publication of unexamined applications
 - 2,380,000
 - (1993.1~2001.10)
- Patent Gazette
 - 880,000
 - (1994.1~2001.10)
- 1,100 CD-ROMs
- 800 GB



Most references in Japanese patents are in description





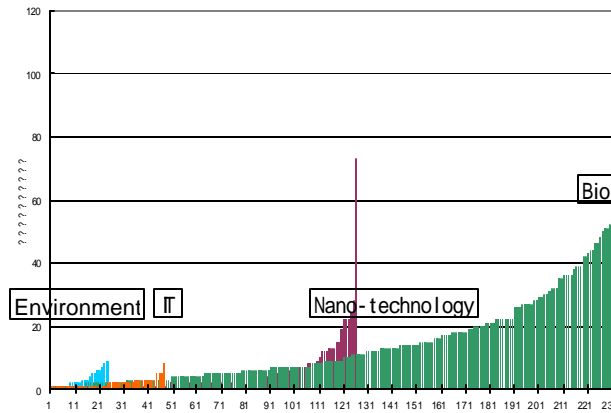
1. Extracting cited papers and patents by hand



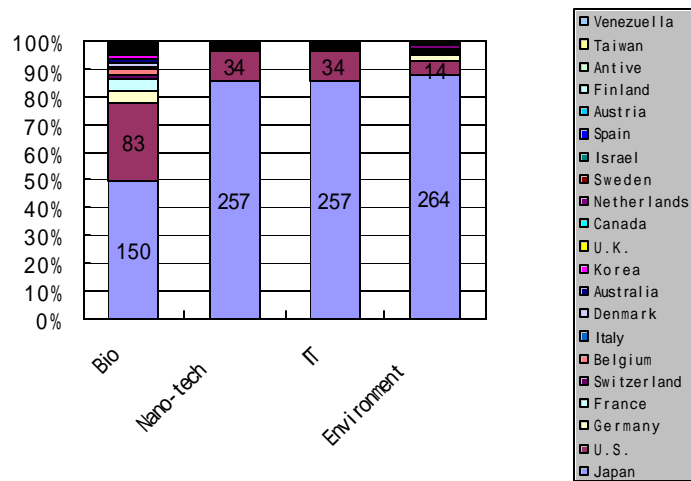
Data used

- Patents granted since 1995 to 1999
- Using filtering program, patents in four priority technological fields in the Japanese Science and Technology Basic Plan was filtered out.
- Out of those patents in each technological field, 300 patents are randomly sampled.
- As control, 300 patents are randomly sampled.

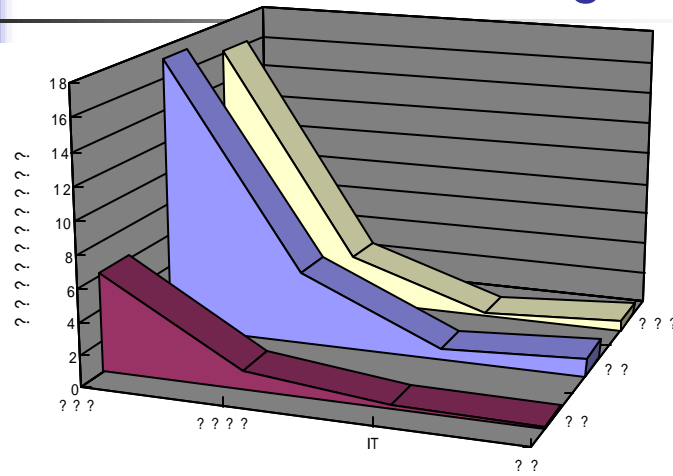
Number of cited papers in each technological field



Nationality of assignee



Science linkage of patents invented in various region



Preliminary findings

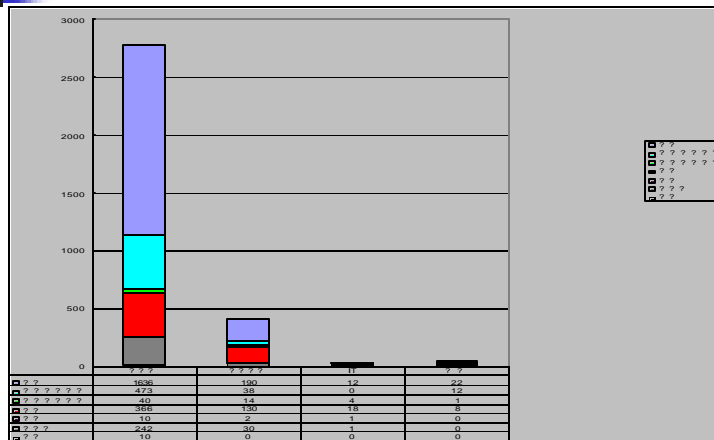
- We constructed an original Japanese patent database and specialized workstation.
- Similar to the U.S. and the EU, inventors cite many academic papers in the Japanese Patent System.
- But they are not in the front page but in the description of the patent gazettes
- Manual extraction of reference cited in patents is labor intensive and time consuming. Therefore, full-automatic extraction of cited reference in the texts of the patent applications is necessary.

2. Who supports who's scientific research cited by whose patents

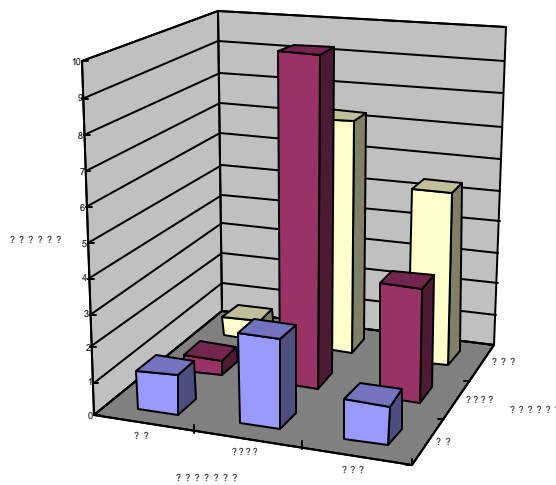
Accumulation of cited papers



Characteristics of organization of cited patents



U.S. papers are cited most even in patents invented in EU and Japan





Supporting body of biotech papers

Not supported	1002	23%
NIH	547	13%
NSF	222	5%
NCI (National Cancer Institute)	200	5%
USPHS (U.S. Public Health Service)	168	4%
American Cancer Society	157	4%
Ministry of science and education, Japan	93	2%
National Institute of General Medical Sciences	89	2%
Deutsche Forschungsgemeinschaft	66	2%
U.S. DOE	57	1%



Preliminary findings

- Most of the authors of papers cited in patents belong to academia i.e. universities and public labs.
- U.S. papers are most cited by inventions in Europe and Japan.
- 77% of accumulated papers in biotechnology are publicly funded.

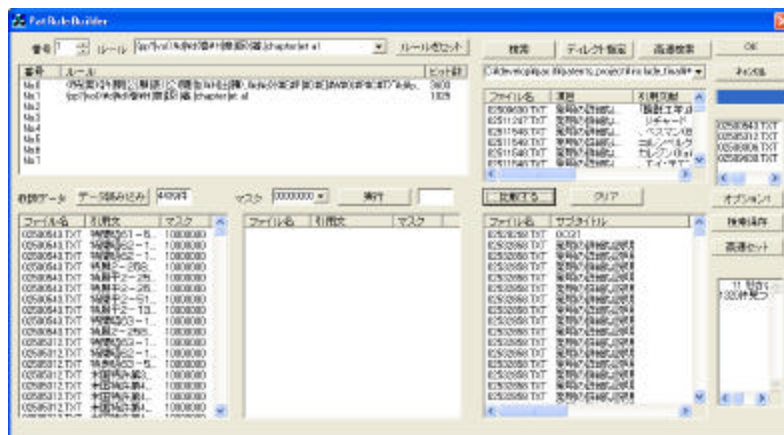
3. Full-automatic extraction of cited references

Performance indicator for automated reference extraction
(Recall ratio=R, Precision ratio=P)

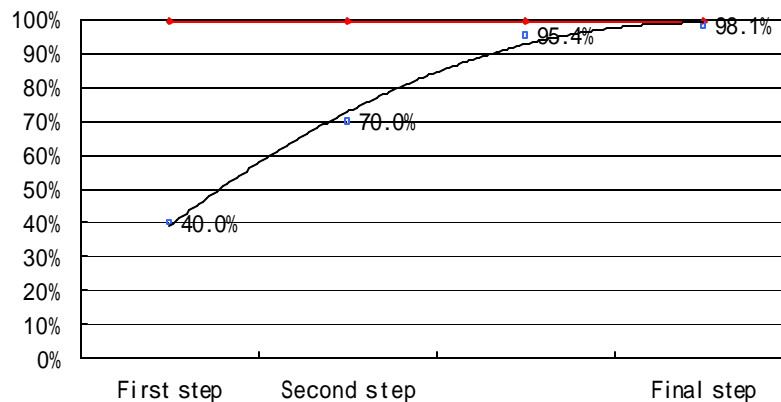
	Reference extracted automatically	Reference not extracted automatically
Matched	w	x (leakage)
Unmatched	y (noise)	z

$$R = \frac{w}{w + x} \quad P = \frac{w}{w + y}$$

Improvement of search formula



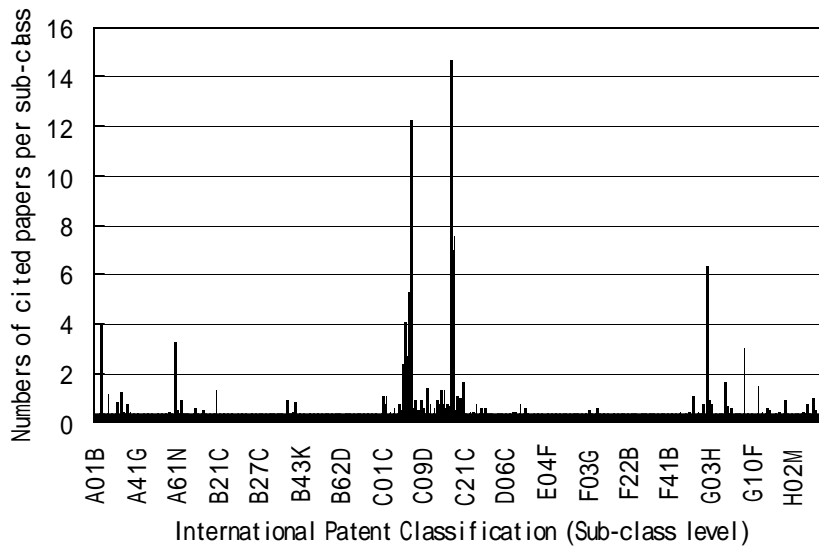
Recall ratio increased by program improvement



Calculation result of automated reference extraction

Categories	patent reference			non-patent reference		
	patenet cited	noise	leakage	non-patent cited	noise	leakage
Env-tech unexam	531	1	0	55	2	11
Env-tech exam	1296	0	5	73	0	3
Mixed unexam	1355	7	6	435	6	18
Mixed exam	2342	14	2	672	11	32
IT-tech unexam	234	2	4	46	8	2
IT-tech exam	977	5	6	115	2	18
Bio-tech unexam	875	14	6	3420	112	31
Bio-tech exam	1322	25	13	4267	22	32
Nano-tech unexam	476	4	2	83	11	11
Nano-tech exam	1867	1	1	213	3	14
SUM	11275	73	45	9379	177	172
	Recall ratio		99.6%	Recall ratio		98.2%
	Precision ratio		99.4%	Precision ratio		98.1%

Significant difference in science linkage among different technological classifications



Ranking of Technological Fields (top 10)

-Which technological field represents strong science linkage in Japan?-

Sub-classes	Number of Patents	Science Linkage
C12N MICRO-ORGANISMS OR ENZYMES; COMPOSITIONS THEREOF; PROPAGATING, PRESERVING, OR MAINTAINING MICRO-ORGANISMS; MUTATION OR GENETIC ENGINEERING; CULTURE MEDIA	44425	14.6
C07K PEPTIDES	18390	12.3
C12Q MEASURING OR TESTING PROCESSES INVOLVING ENZYMES OR MICRO-ORGANISMS; COMPOSITIONS OR TEST PAPERS THEREFOR; PROCESSES OF PREPARING SUCH COMPOSITIONS; CONDITION-RESPONSIVE CONTROL IN MICROBIOLOGICAL OR ENZYMOLOGICAL PROCESSES	5442	7.6
C12P FERMENTATION OR ENZYME-USING PROCESSES TO SYNTHESISE A DESIRED CHEMICAL COMPOUND OR COMPOSITION OR TO SEPARATE OPTICAL ISOMERS FROM A RACEMIC MIXTURE	9617	7.0
G03C PHOTSENSITIVE MATERIALS FOR PHOTOGRAPHIC PURPOSES; PHOTOGRAPHIC PROCESSES, e.g. CINE, X-RAY, COLOUR, STEREO-PHOTOGRAPHIC PROCESSES; AUXILIARY PROCESSES IN PHOTOGRAPHY	24018	6.3
C07J STEROIDS	1373	5.3
C07H SUGARS; DERIVATIVES THEREOF; NUCLEOSIDES; NUCLEOTIDES; NUCLEIC ACIDS	2837	5.0
C07D HETEROCYCLIC COMPOUNDS	24241	4.1
A01H NEW PLANTS OR PROCESSES FOR OBTAINING THEM; PLANT REPRODUCTION BY TISSUE CULTURE TECHNIQUES	596	4.0
A61K PREPARATIONS FOR MEDICAL, DENTAL, OR TOILET PURPOSES	23852	3.3

Ranking of Technological Fields (11~ 20)

-Which technological field represents strong science linkage in Japan?-

Sub-classes	Number of Patents	Science Linkage
G09C CIPHERING OR DECIPHERING APPARATUS FOR CRYPTOGRAPHIC OR OTHER PURPOSES INVOLVING THE NEED FOR SECURITY	233	3.0
C07C ORGANIC COMPOUNDS OF UNKNOWN CONSTITUTION	138	2.7
C07F ACYCLIC, CARBOCYCLIC, OR HETEROCYCLIC COMPOUNDS CONTAINING ELEMENTS OTHER THAN CARBON, HYDROGEN, HALOGEN, OXYGEN, NITROGEN, SULFUR, SELENIUM, OR TELLURIUM (metal-containing porphyrins)	3651	2.6
C08B POLYSACCHARIDES; DERIVATIVES THEREOF (polysaccharides containing less than six saccharide radicals attached to each other by glycosidic linkages; fermentation or enzyme-using processes; sugar industry; production of cellulose)	1155	2.6
C07B GENERAL METHODS OF ORGANIC CHEMISTRY; APPARATUS THEREFOR	468	2.3
C07C ACYCLIC OR CARBOCYCLIC COMPOUNDS	45291	2.0
C14C CHEMICAL TREATMENT OF HIDES, SKINS OR LEATHER, e.g. TANNING, IMPREGNATING, FINISHING, APPARATUS THEREFOR, COMPOSITIONS FOR TANNING	51	1.6
G06E OPTICAL COMPUTING DEVICES	56	1.6
G10L SPEECH ANALYSIS OR SYNTHESIS; SPEECH RECOGNITION	1761	1.6
C09H PREPARATION OF GLUE OR GELATINE	18	1.4



Major findings & conclusion

- Similar to the U.S. and the EU, inventors cite many academic papers in the texts of the patent applications in the Japanese Patent System.
- Full-automatic extraction of cited reference in the texts of the patent applications is accomplished.
- The science linkage index among different patent classifications differs significantly.
- The pattern of difference of science linkage index was similar in the EU and Japan.
- It suggests that the process of creating new technology differs from technology to technology.



Useful conceptual frameworks & policy recommendations (new)

- Information vs. entropy
 - To require inventors and applicants to provide precise information before putting them into the database is much costless than to clean the information up after having put wrong information and clean them all
- Patent vs. (Privacy & Trade Secret)
=Public Interest vs. Private Interest
 - If a policy that require applicants to provide additional information accelerate the speed of innovation, that policy should be put into practice.
 - Like JPO applicant code, introducing universal system of applicant code and inventor code is a good policy example.