

# Management of technology for forming a global innovation base and developing human resources

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# What is “Innovation”?

"Innovation" is the change that leads  
economical success.

By Akira Goto (2000)

# Two stages for “Innovation”?

1<sup>st</sup>: Making “Change”

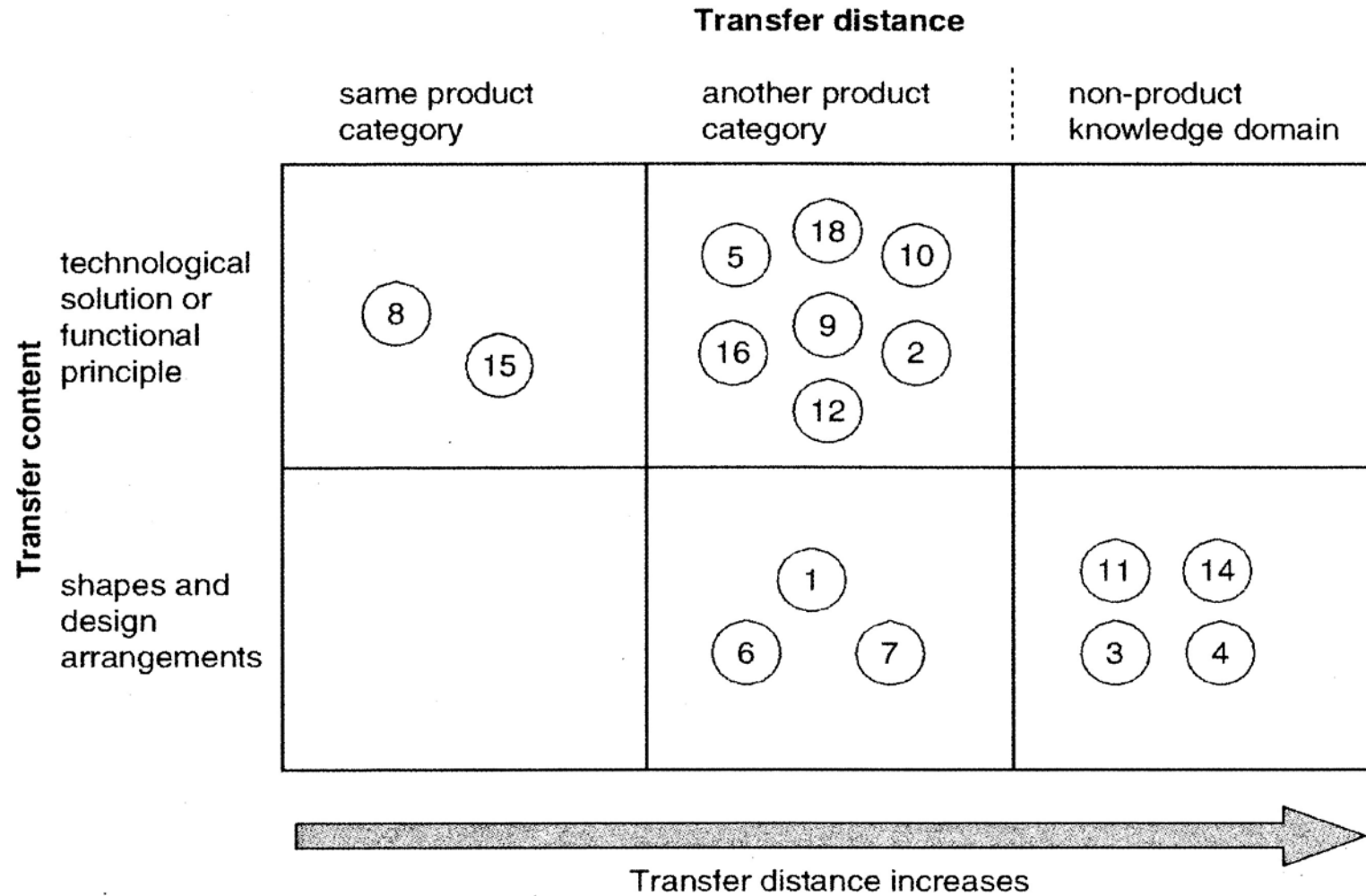
2<sup>nd</sup>: Handling the "Change" to become a social value

# 1<sup>st</sup> Stage;

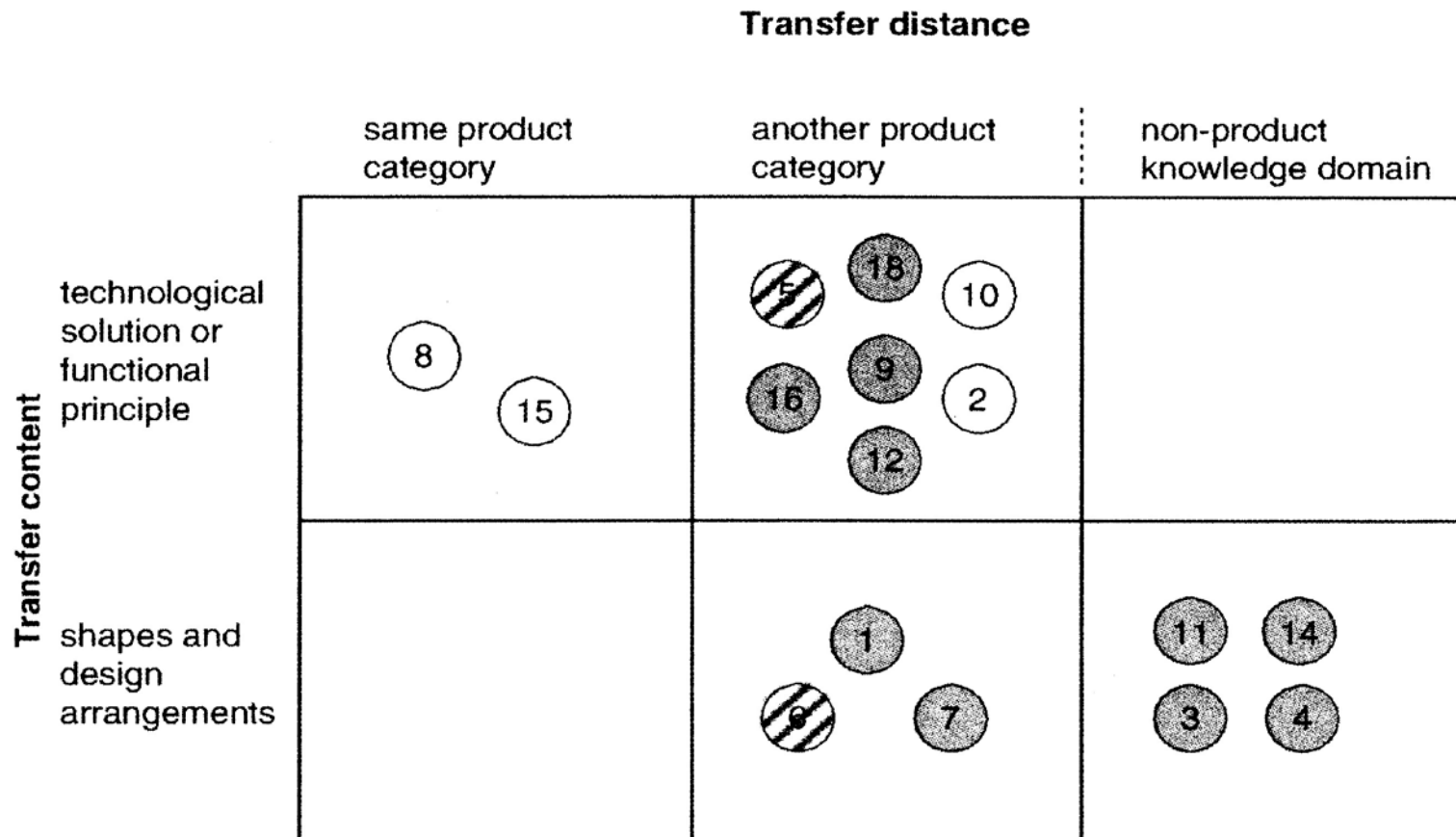
## Making a change for Technological Innovation: Invention & Knowledge creation


- ◆ Transfer distance of analogy
- ◆ Influence of diversity in composition members on science research team
  - ◆ Purpose of present study
  - ◆ Studying method: Investigation object, range of investigation, and methods of analysis
  - ◆ Result and consideration


# Analogy and Creativity




# Analogy and Creativity



 = radically new for the client and the market

 = radically new for the client, but not for the market

 = incrementally new for the client and the market

# becoming the knowledge society

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*The omni-directional progress of technologies and the rapid increase in the industrial activity based on technologies would be able to be called as the most remarkable feature of 20th century. Then the base of such technologies is the science. (omission) The 20th century is the age of the knowledge explosion brought by the rapid progress of the science.*

テクノロジーの全方位的発展とそれを利用しての産業活動の飛躍的増大が20世紀最大の特徴といえるだろうが、テクノロジーの基盤にあるのがそれを支えるサイエンスである。(中略)20世紀はサイエンスの急発展によってできた知識爆発の時代であるといえることができる。

— Takashi Tachibana (立花 隆)

# Research question

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RQ: Constitution that efficiently creates science wisdom under specific condition  
One solution is to organize diversity?



## Performance of organization and previous work concerning member diversity

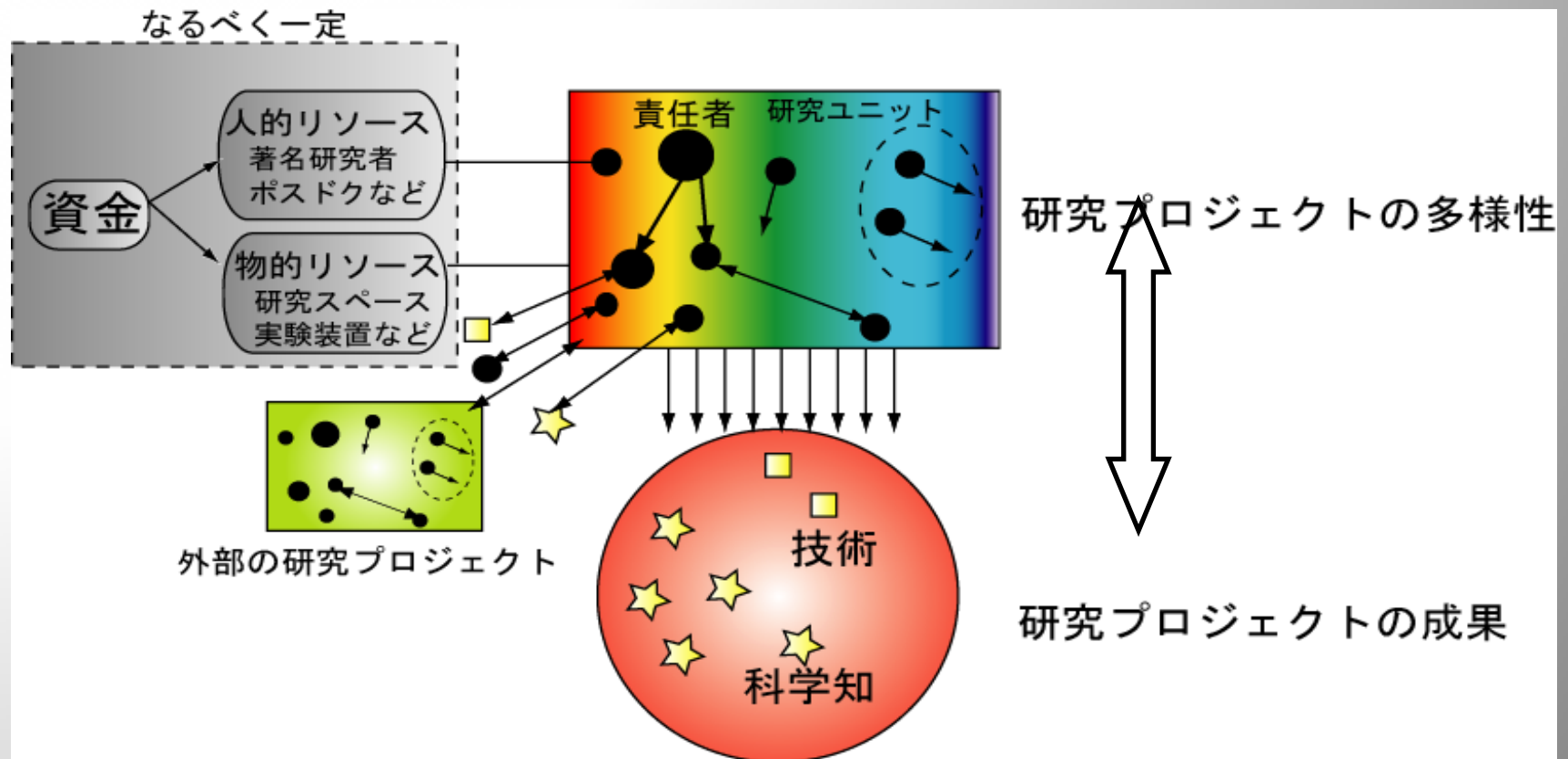
*In international organization (Fortune 500 telecommunications firm), a strong correlation between external knowledge sharing and the performance was observed when the diversity of the project member was high.*

Jonathon N. Cummings, *Management Science*, **50**, 352-364, (2004)



# Purpose of the research

Clarifying the relation between the creation of science knowledge and the diversity of the research project member in some certain condition



# Research method ①: Condition of investigating

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< condition of investigation object necessary to achieve investigative purpose  
>

1. The purpose of the organization is in "Creation of state-of-the-art science knowledge".
2. Enough amount of the resource was turned on.
3. "Creation of science knowledge" can be measured accurately.
4. The organization is made considering diversity.

# Research method ②: Investigation object - ERATO (strategic creation research promotion business)

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## < key properties of ERATO >

Kind of research: Pure research that develops new research field

Research organization: Project system driven by a representative researcher. Participation of the researcher from other organizations

Period: 5 years. No extension.

Resource: About 1.5 billion yen for five years

Laboratory: Borrowing from research park, private laboratories, or universities

Result: A positive announcement such as academic conference presentation and the prepublication paper is an obligation.

Project: 21 and completion 77 when being progressing (at the time of, April 1, 2009)

# 研究方法②：ERATOの成果

## <ERATOの成果>

	2006年3月31日時点			
	種目	国内	海外	計
Patent application number	特許出願件数	1,445	808	2,253
Number of announcement to the outside	外部発表件数	8,017	7,096	15,113

(注) 終了プロジェクトを含めた累計

### Example of epoch-making knowledge that arose from project of ERATO

Discovery of new superconducting material of iron system by Prof. Hideo Hosono at Tokyo Institute of Technology frontier research center et al. (The most cited article in 2008)

Research of the asymmetric synthesis reaction by "Noyori molecular catalyst project". (Contributed to the Nobel prize winning. )

# Research method ②: Range of investigation

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Research object : Project of which evaluation report showing researcher's background and research results that can be measured has been published.

16 projects that were started between 1993 and 1996.

\*A current number of total end projects is 77.

## Research method ②: Details within the range of investigation

開始年	終了年	プロジェクト名	分野別
1993	1998	山本量子ゆらぎ	バイオ
1993	1998	田中固体融合	
1993	1998	橋本相分離構造	
1993	1998	広橋細胞形象	
1994	1999	高柳粒子表面	バイオ バイオ
1994	1999	平尾誘起構造	
1994	1999	山元行動進化	
1994	1999	高井生体時系	
1995	2000	舛本単一量子点	バイオ バイオ バイオ
1995	2000	加藤たん白生態	
1995	2000	土居バイオアシンメトリ	
1995	2000	御子柴細胞制御	
1996	2001	川人学習動態脳	バイオ バイオ バイオ
1996	2001	井上光不斉反応	
1996	2001	横山情報分子	
1996	2001	月田細胞軸	

total: 98

種目	2006年3月31日時点		
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<small>(注) 終了プロジェクトを含めた累計</small>			

< research result total of extracted project (16) >

	国内	海外	計
特許出願件数	194	50	244
外部発表件数	1499	1498	2997

# Methods of analysis

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The diversity of the research project member is evaluated in diversity index D.

$$D = R_f + R_c$$

$R_f$  = (number of foreigners in project team)  
/ (number of total project members)

$R_c$  = (number of project members who come from company)  
/(number of total project members)

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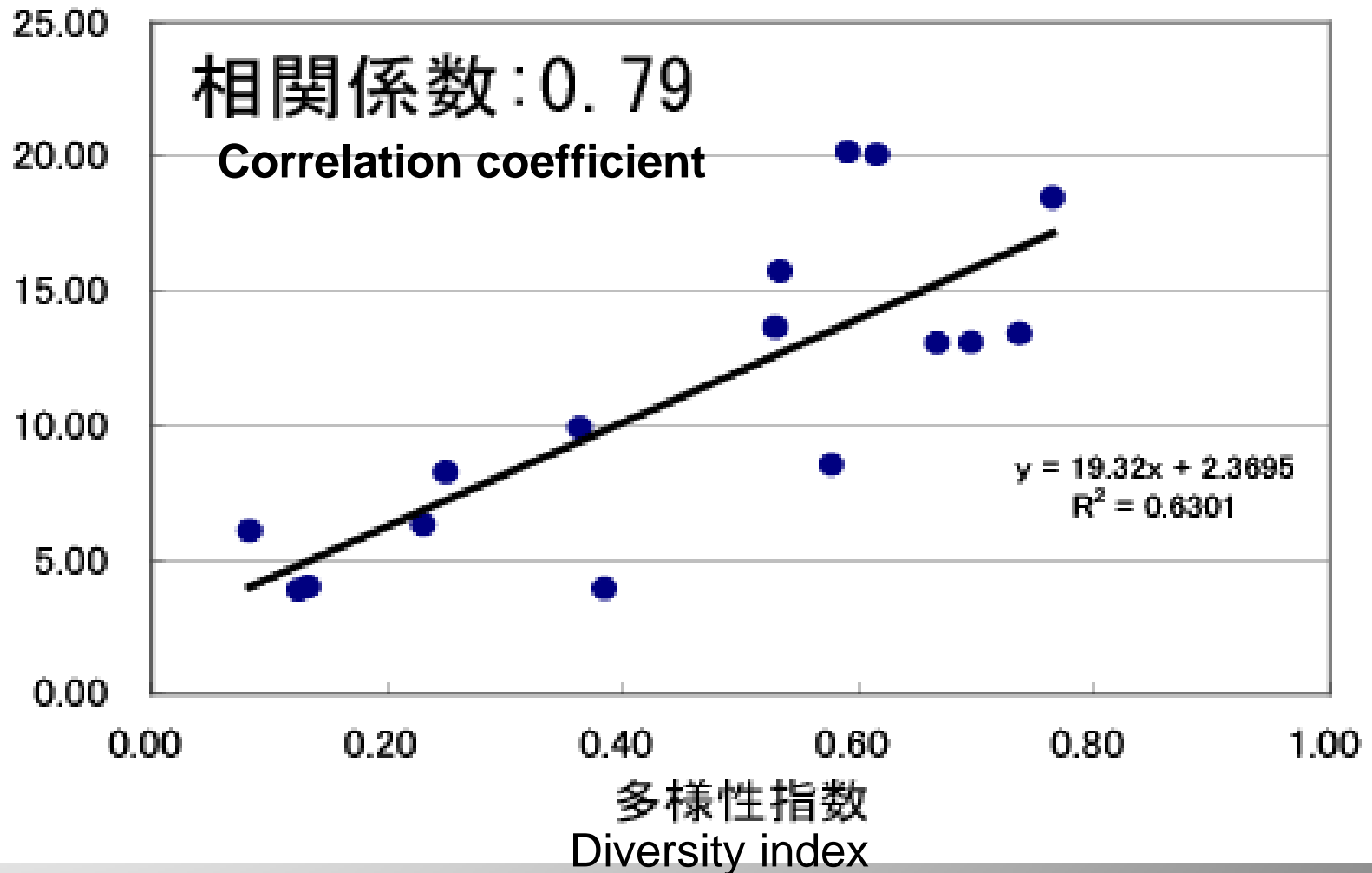
\*We assumed that amount of the created science knowledge is proportional to the number of announcement to the outside.

\* Since the number of members was different in each project, we evaluated the efficiency of the science knowledge creation by the number of announcements per person of the member.

# Result

There is a strong correlation in the total announcement and the diversity index.

Number of the announcement to the outside  
per person of member

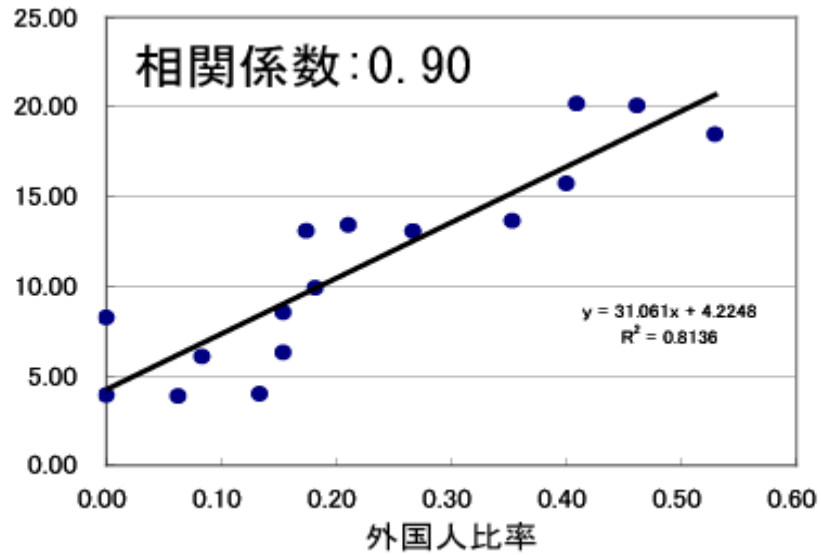




# Result

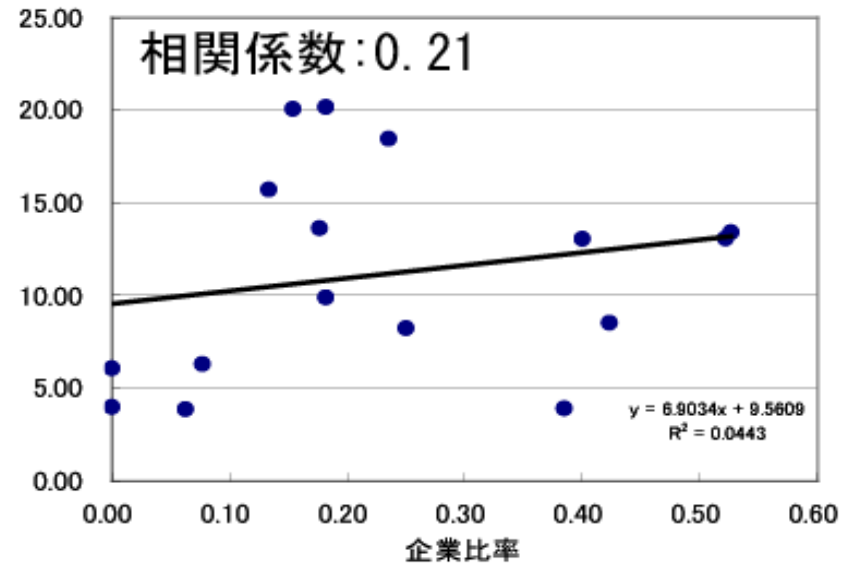
Only the ratio of foreigners correlates and exists with the number of announcements.

Number of announcement per person



$R_f$

Number of announcement per person

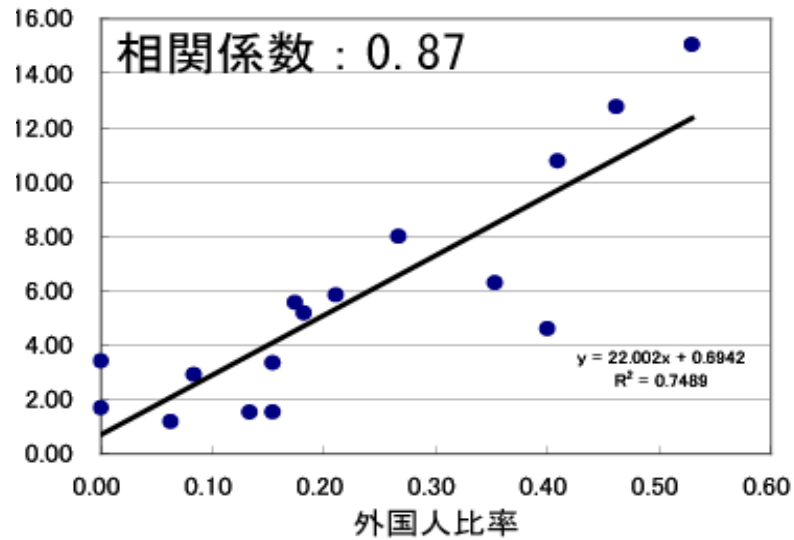


$R_c$

# Result

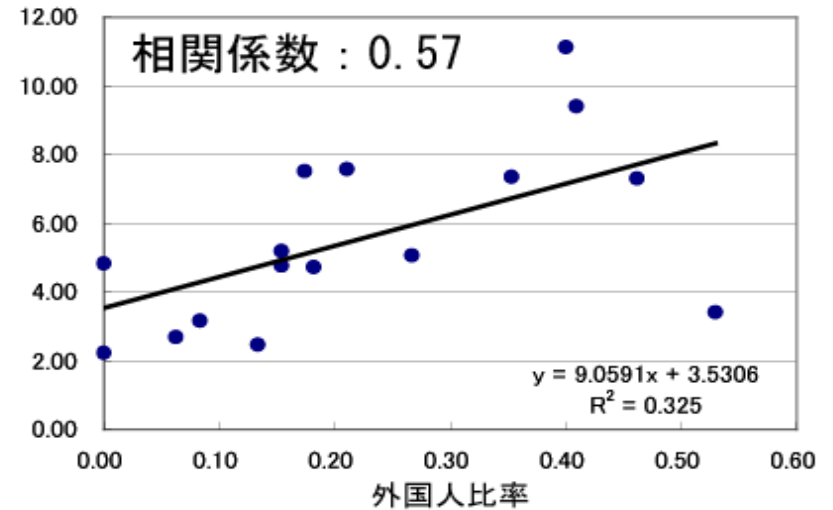
Both domestic announcements and overseas announcements correlate to  $R_f$ .

Number of overseas announcement  
per person



$R_f$

Number of domestic announcement  
per person



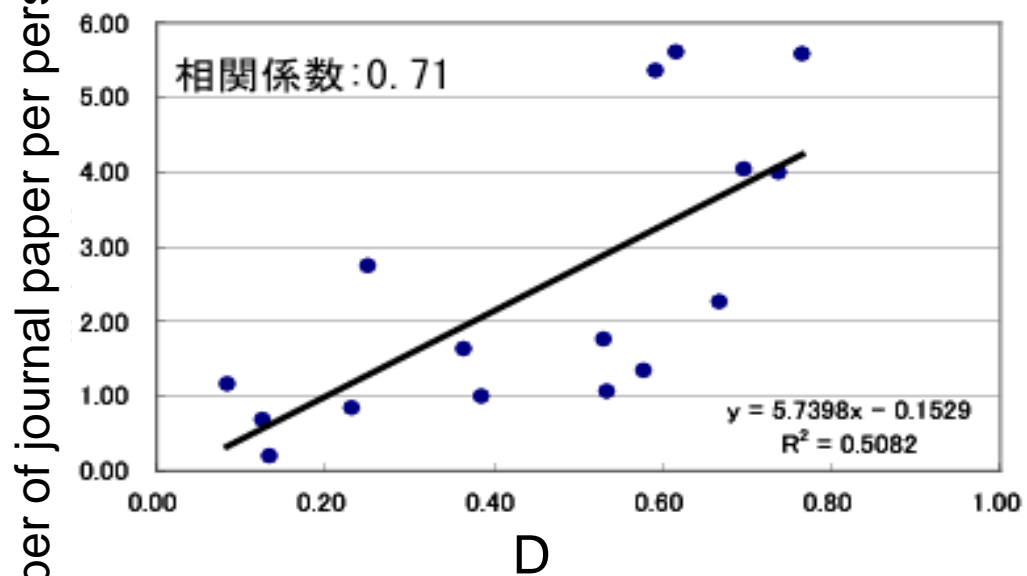
$R_f$

Not only language effect!

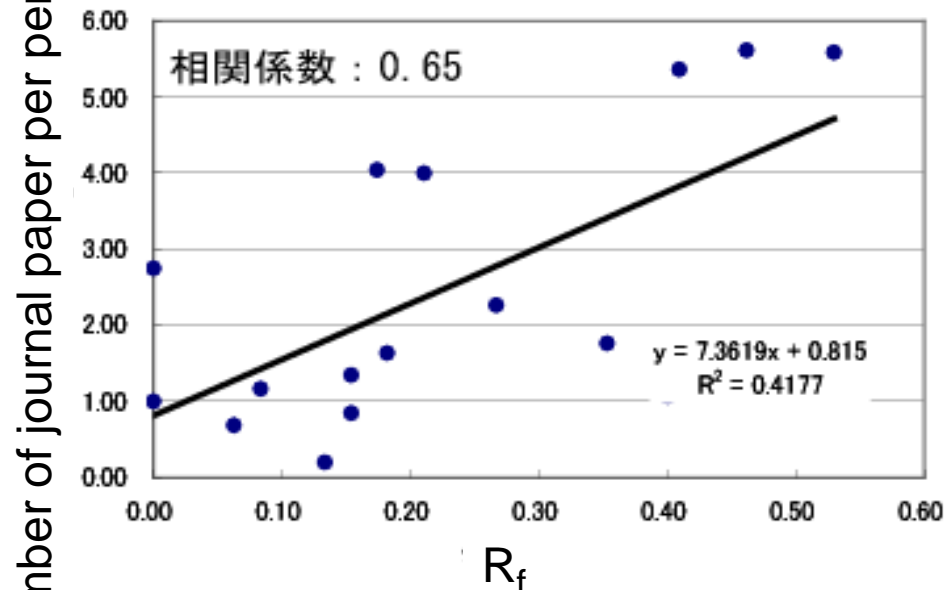
# Result

counting only journal papers

(1) (D) vs (Number of journal papers)



(2) ( $R_f$ ) vs (Number of journal papers)

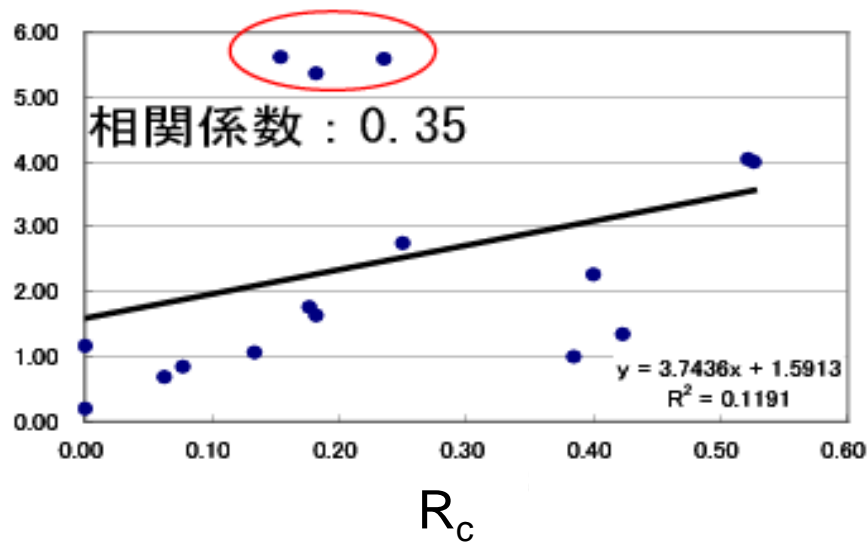


# Result

(R<sub>c</sub>) vs (Number of journal papers)

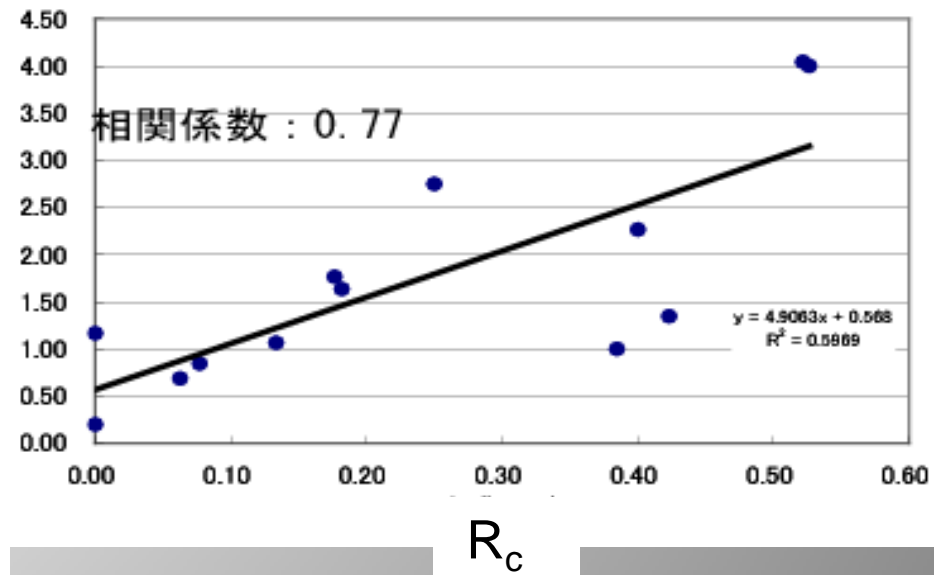
Number of journal paper per person

Including projects of 50% or more in R<sub>f</sub>



Number of journal paper per person

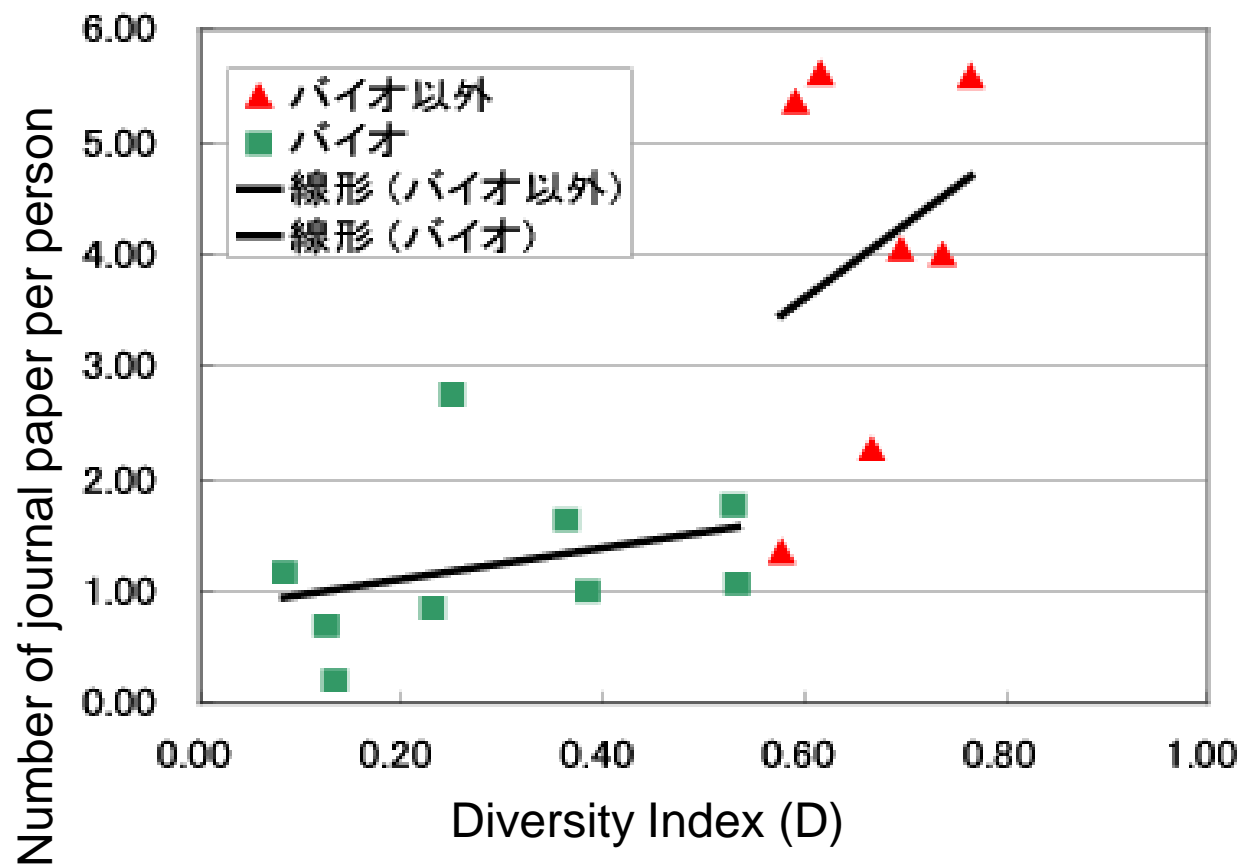
Project of 50% or less in R<sub>f</sub> only



# Result

## Feature of research related to biotechnology

(1) (D) vs (Number of journal papers)



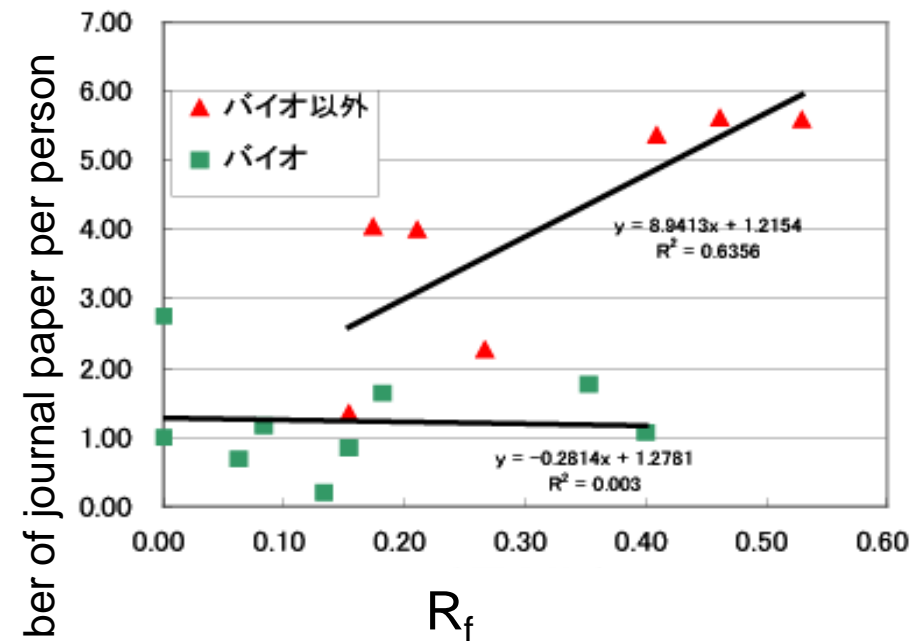
▲ Projects other than biotechnology

■ Project related to biotechnology

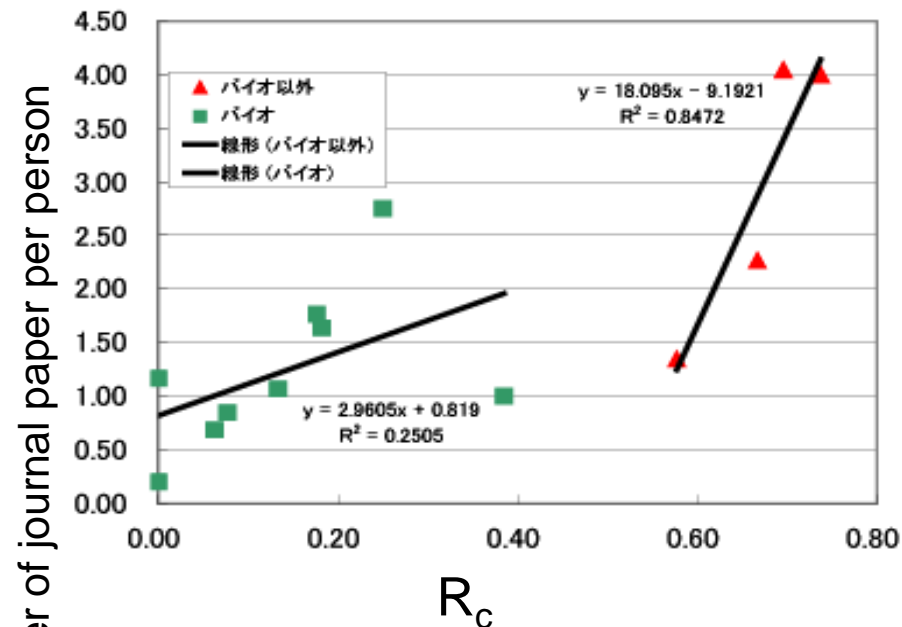
# Result

## Feature of research related to biotechnology

(2)  $(R_f)$  vs (Number of journal papers)



(3)  $(R_c)$  vs (Number of journal papers)



Project related to biotechnology



Projects other than biotechnology

# Conclusion

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- ◆ The creation efficiency of science knowledge depends on the diversity of the project team member.
- ◆ The creation efficiency of science knowledge is improved by participation of company researcher.
- ◆ The efficiency of science knowledge creation by the foreign researcher's participation depends on the field of science.

## 2<sup>nd</sup> Stage;

# Handling the “Change” to become a social value

- ◆ Research capability and industrial competitiveness
  - ◆ Research institute rankings in citations
  - ◆ Citations ratio to the United States
  - ◆ Role of researcher in enterprises



# Research institute rankings in citations (2002.1-2012.2)

## Chemistry

Kyoto Univ.	4
Univ. of Tokyo	5
JST	11
AIST	13
Osaka Univ.	15
Tohoku Univ.	23
Tokyo Institute of Technology	30
Kyushu Univ.	49
Nagoya Univ.	57
Hokkaido Univ.	61

## Material Science

Tohoku Univ.	3
AIST	8
Osaka Univ.	17
Univ. of Tokyo	21
Kyoto Univ.	26
JST	24
Tokyo Institute of Technology	29
Kyushu Univ.	62
Hokkaido Univ.	94
Nagaya Univ.	105

## Engineering

Univ. of Tokyo	23
Kyoto Univ.	52
Tohoku Univ.	53
AIST	66
Tokyo Institute of Technology	75
JAEA	82
Kyushu Univ.	96

## Computer Science

Tokyo Metropolitan Univ.	10
Univ. of Tokyo	57

Based on ISI Web of Knowledge

# Research institute rankings in citations (2002.1-2012.2)

Psychiatry and Psychology	
No Jp Institute	
Chinese University of Hong Kong	143
The Univ. of Hong Kong	173
<b>Univ. of Tokyo</b>	<b>322</b>
<b>Total 432</b>	

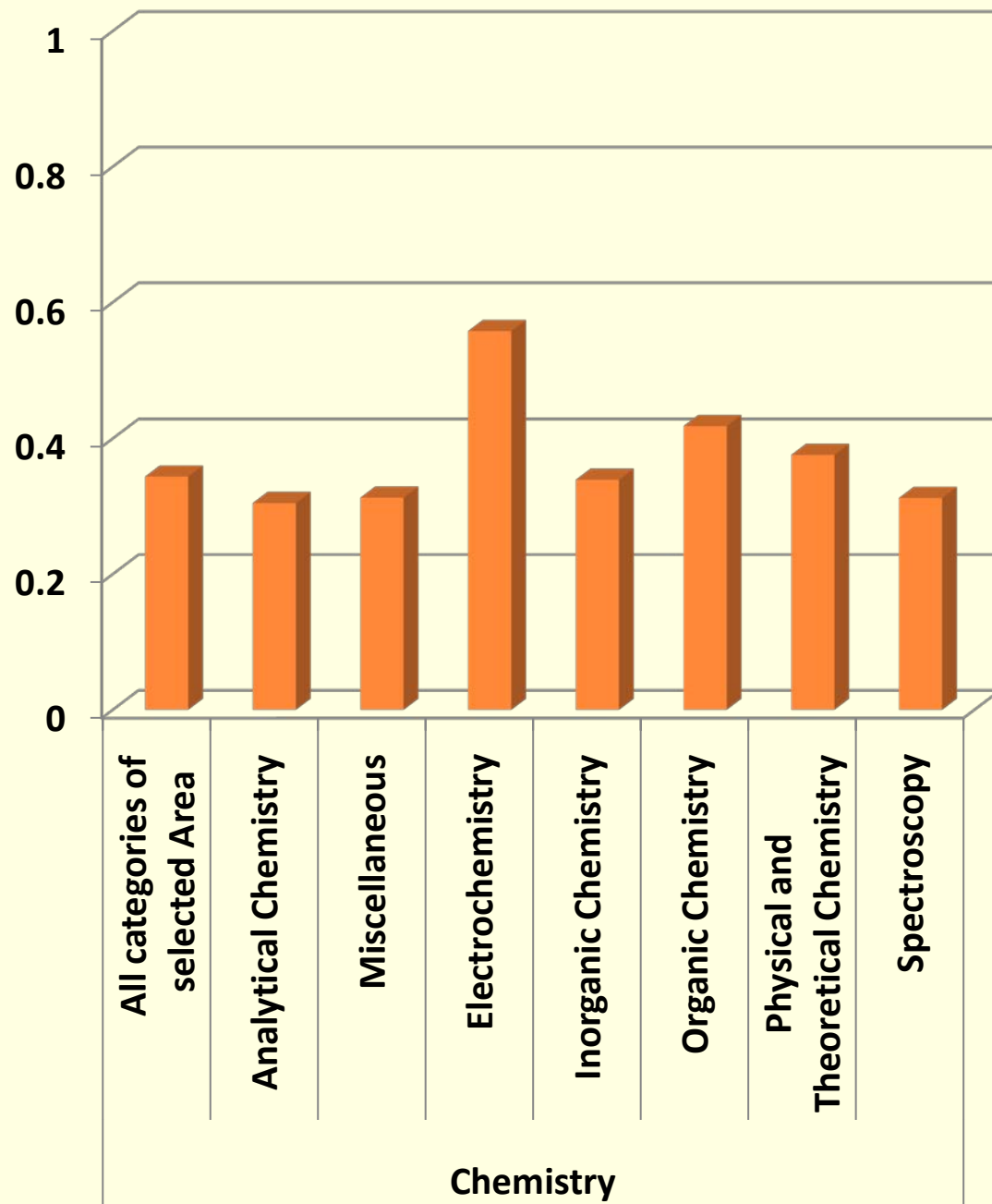
Social Sciences, General	
No Jp Institute	
The Univ. of Hong Kong	140
Chinese University of Hong Kong	169
The Hong Kong Polytechnic Univ.	217
<b>Univ. of Tokyo</b>	<b>275</b>
<b>Total 825</b>	

Economics and Business	
No Jp Institute	
National Univ. of Singapore	58
The Hong Kong Univ. of Science and Technology	63
Chinese Univ. of Hong Kong	70
City Univ. of Hong Kong	97
The Hong Kong Polytechnic Univ.	104
The Univ. of Hong Kong	130
Korea Univ.	180
Nanyang Technological Univ	188
National Taiwan Univ.	192
<b>Total 212</b>	

Based on ISI Web of Knowledge

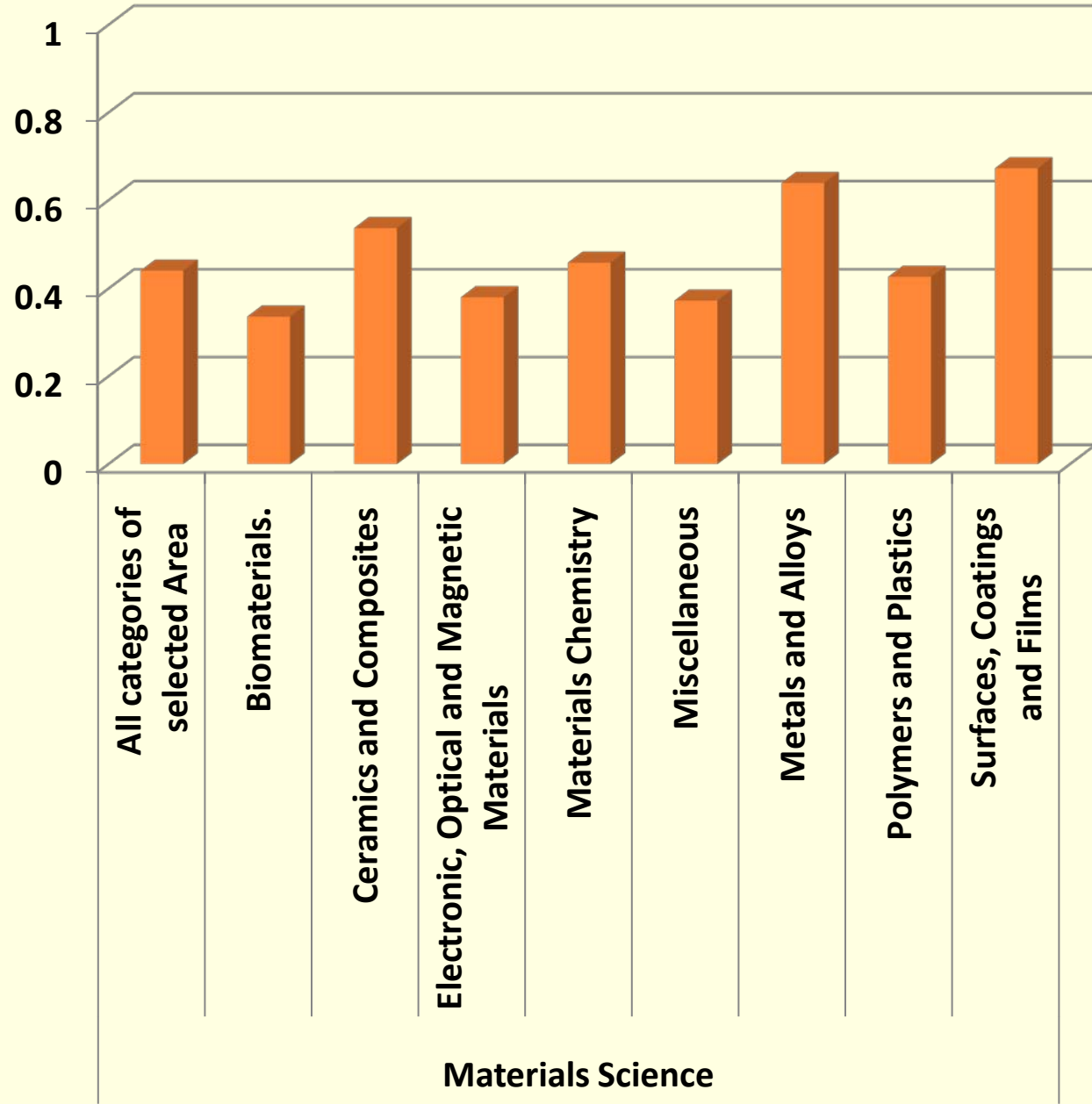
Citations ratio to  
the USA

Chemistry



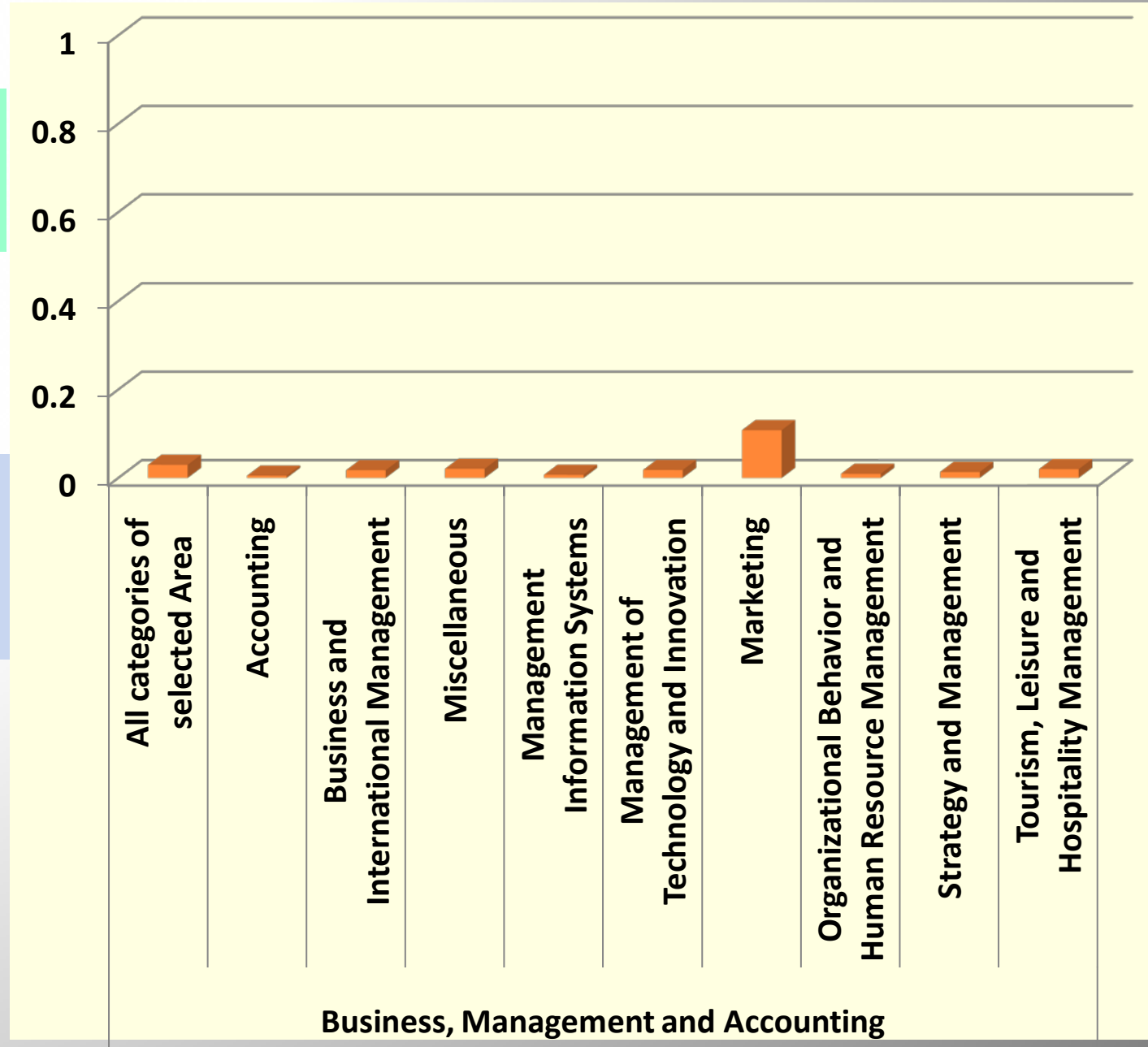
Citations ratio to  
the USA

Materials Science



# Citations ratio to the USA

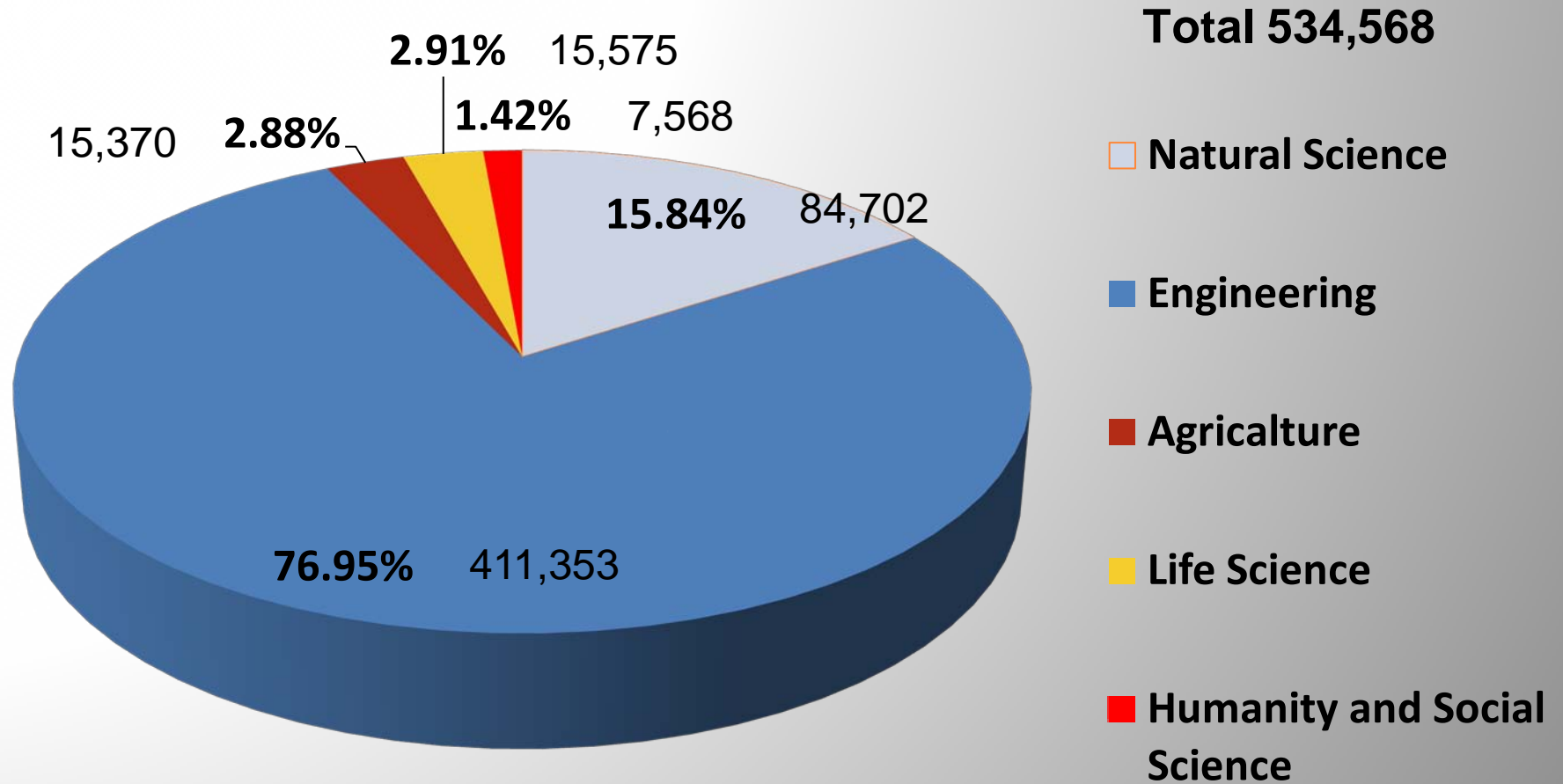
## Business, Management and Accounting



# Research capability and industrial competitiveness

- ◆ The industrial competitiveness seems to relate to the research capability in related academic area.
- ◆ The capability of the business research of Japan is remarkably inferior compared with the field of the chemistry and the materials science.

# Research capability and industrial competitiveness



Number of researchers in enterprise

# How do we build the global innovation base?

- ◆ We would be able to alter the efficiency of knowledge creation and invention by increasing knowledge exchange among researchers with different background.
- ◆ The acceptance capability of the society to the change would be also necessary to lead the invention and the created knowledge into the society
- ◆ Infiltration of MOT into the society would be the key for forming the global innovation base.