Towards Evidence-based STI Policy Planning in Socio-economic Context

- Snapshots from Research Outputs of NISTEP -

Naoki SAITO

Deputy Director General

National Institute of Science and Technology Policy (NISTEP)

Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT)

For OECD International Symposium on
STI Policy for the Future

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Today's Topics

I. Key S&T Indicators and Figures for Japan's Science, Technology and Innovation (STI)

II. Snapshots from Recent Research Outputs of NISTEP

(Science Map / Survey on S&T-based Innovation in Industry / Effects of Motivation for research project)

III. NISTEP's Key Mission to Contribute to Evidence-based STI policy-planning toward the Future

(Data & Information Infrastructure for SciREX / Building Database for Career Development of Ph.D Holders / S&T Foresight)

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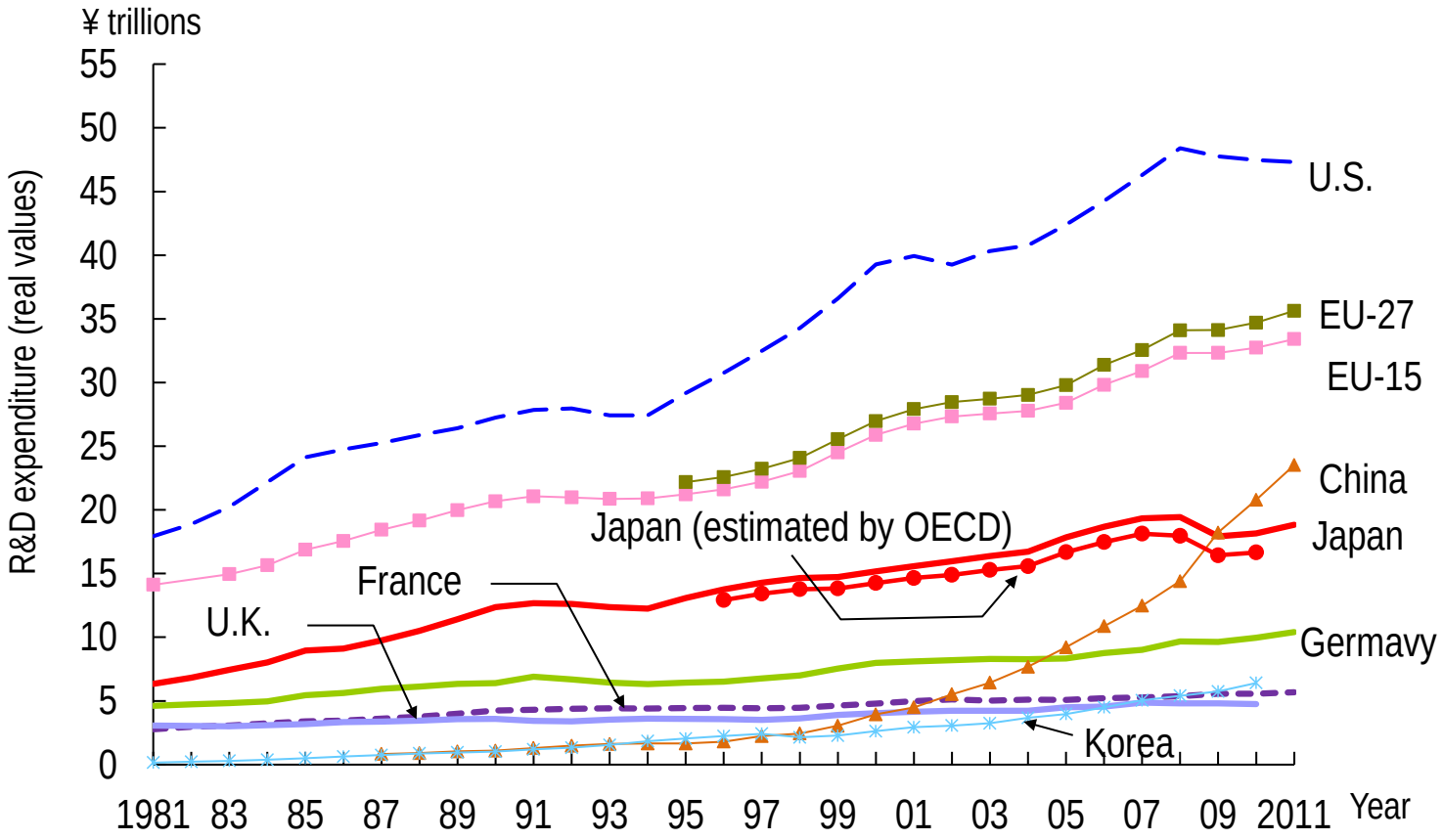
I. Key S&T Indicators and Figures for Japan's Science, Technology and Innovation (STI)

Trend in total R&D expenditure in selected countries ~ Real values (2000 base: OECD PPP equivalent)



– Source: NISTEP, Japanese Science & Technology Indicators 2013, Research Material-225, Aug. 2013

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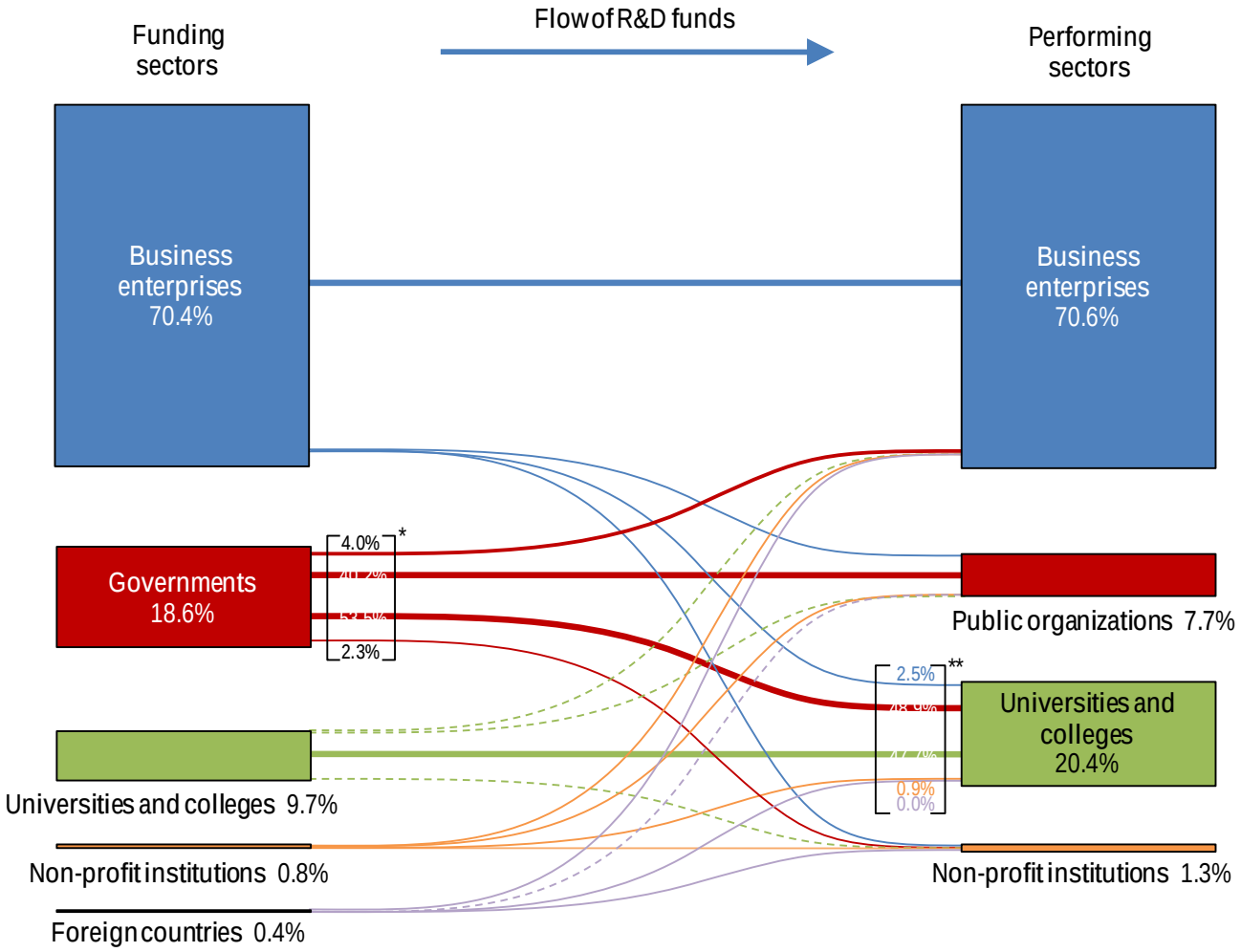
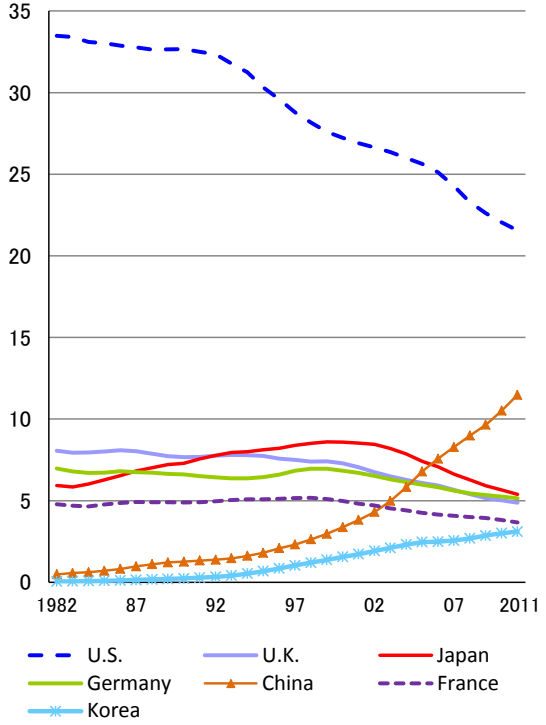
Flow of R&D funds from funding sectors to performing sectors in key countries - Japan（2011）



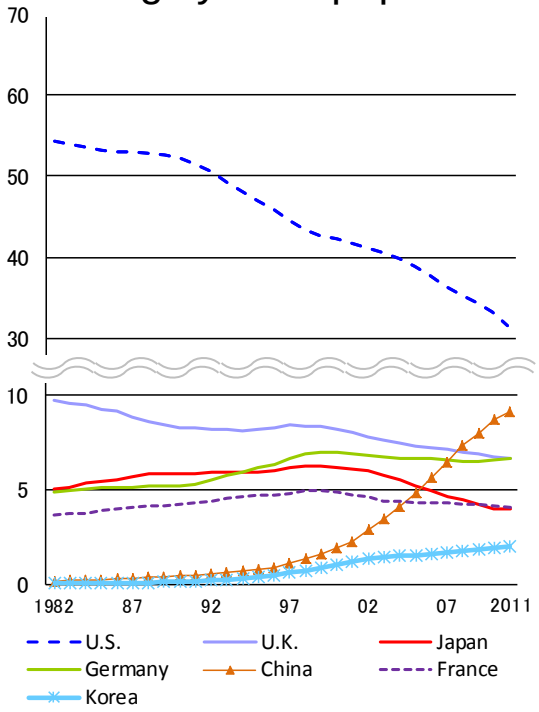
Source: NISTEP, Japanese Science & Technology Indicators 2013, Research Material-225, Aug. 2013

The change in the share of the numbers of papers in main countries

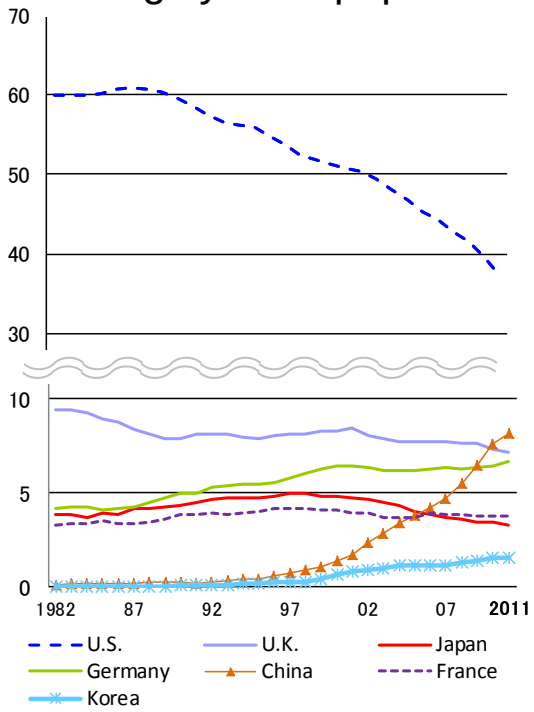
The Share of the number of All papers



The Share of the number of Top10% highly cited papers



The Share of the number of Top1% highly cited papers



Data: 3-years moving average of share tabulated from Thomson Reuters "Web of Science (SCIE, CPCI-S)" by fractional counting.

- Source: NISTEP, Japanese Science & Technology Indicators 2013, Research Material-225, Aug. 2013

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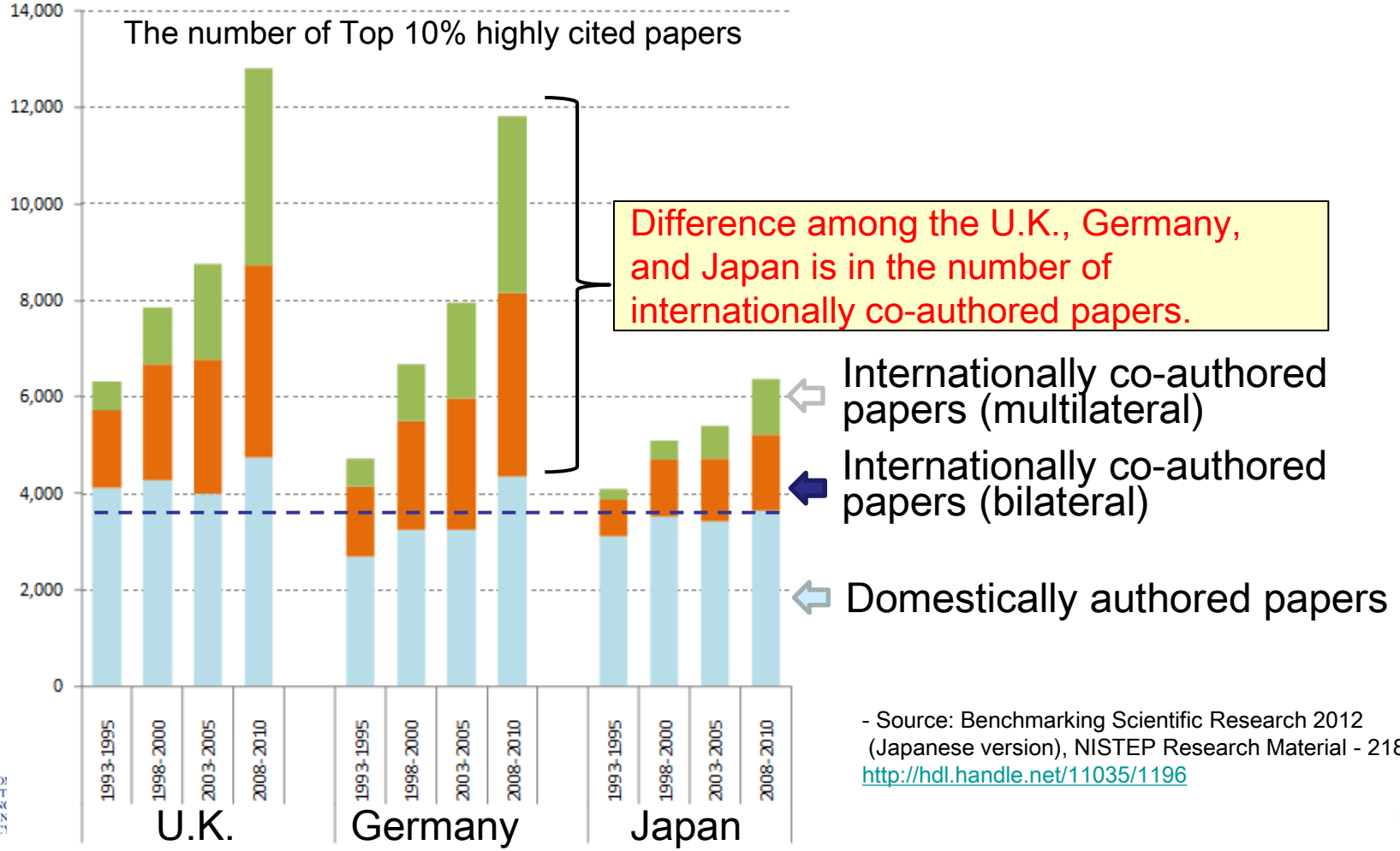
Japan is lagging behind the extensive internationalization of research activities

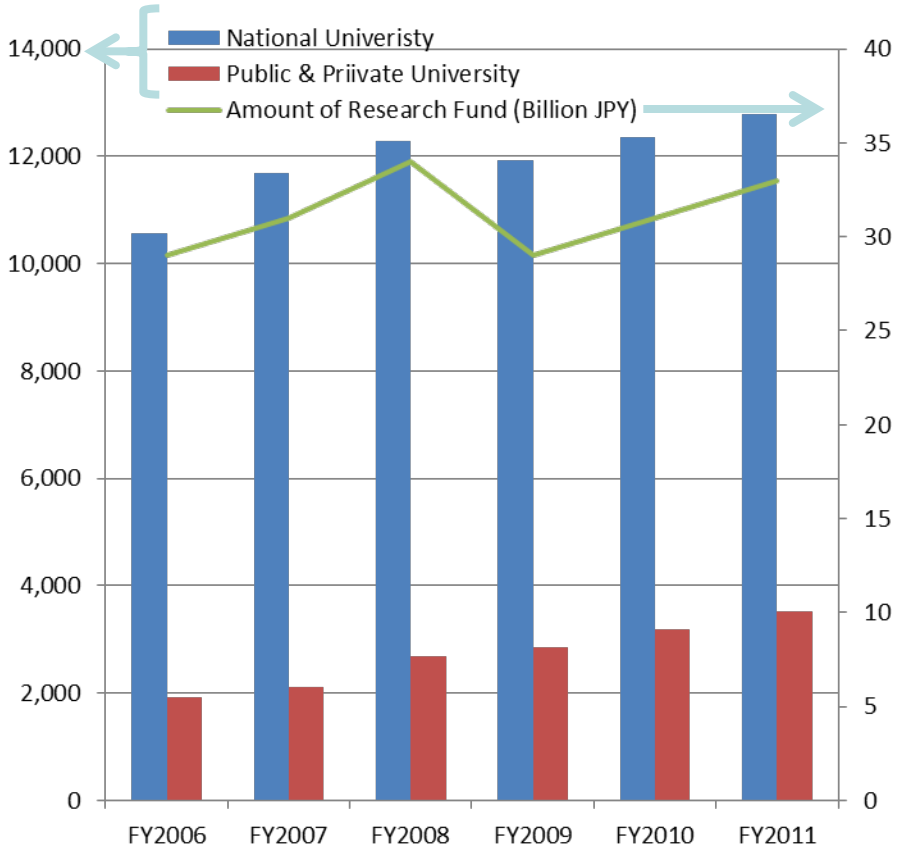
- The numbers of highly citied papers are approximately the same among Japan, the U.K. and Germany in domestically authored papers, but different in the internationally co-authored papers.



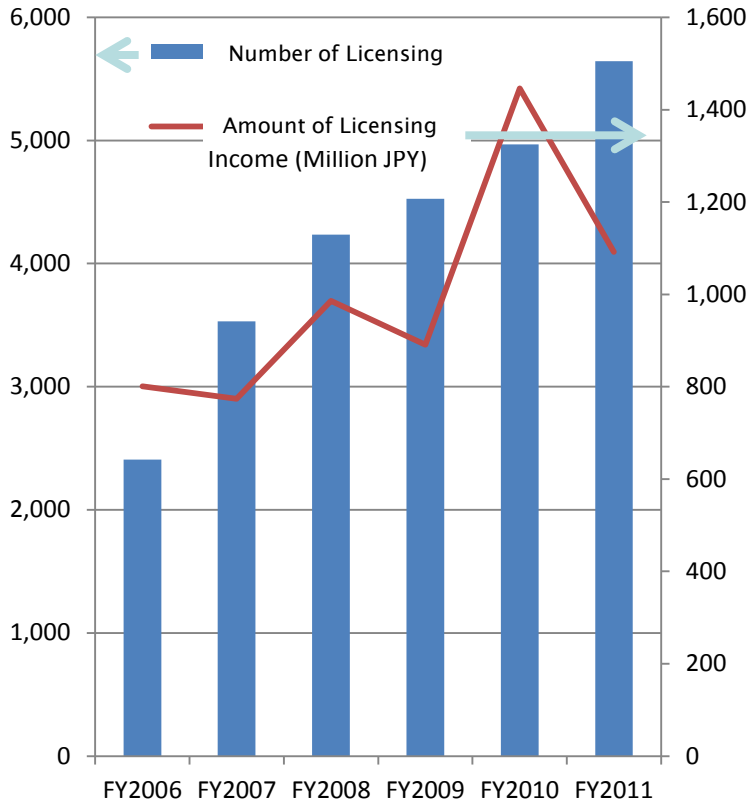
- Source: Benchmarking Scientific Research 2012 (Japanese version), NISTEP Research Material - 218
http://hdl.handle.net/11035/1196

Trends in University-Industry Collaboration

Collaborative Research between University and Industry



Licensing of University Patents



- Source: MEXT Annual Survey on University-Industry Collaboration
(Science & Technology Policy Bureau)

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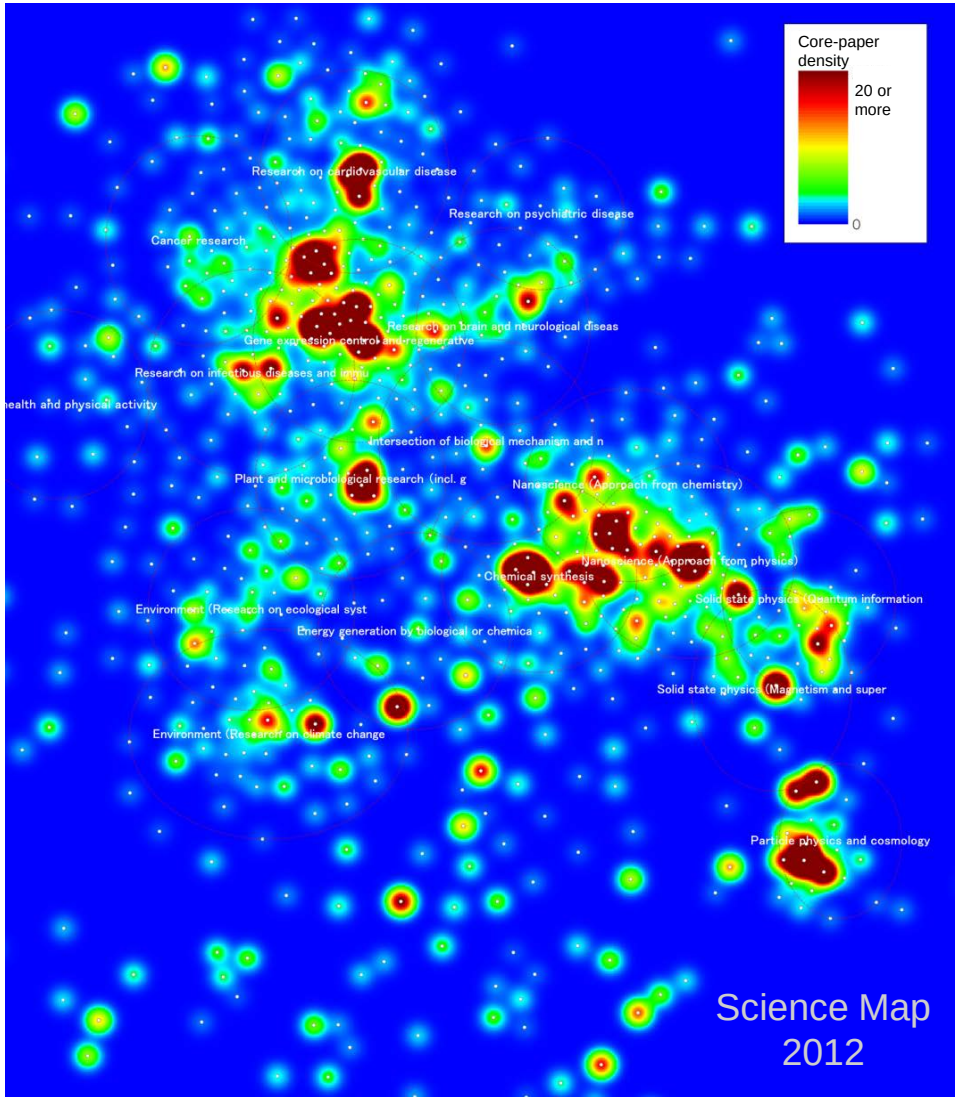
Science Map 2012: Mapping "Hot" Research Areas

- Science Map is a map of scientific research, and it shows the interrelationships among research areas where there is active research today.
- The research areas are generated by clustering the top 1% of highly cited papers, using co-citation analysis.
- The map covers papers published from 2007 to 2012.
- A total of 823 research areas were identified in Science Map 2012.

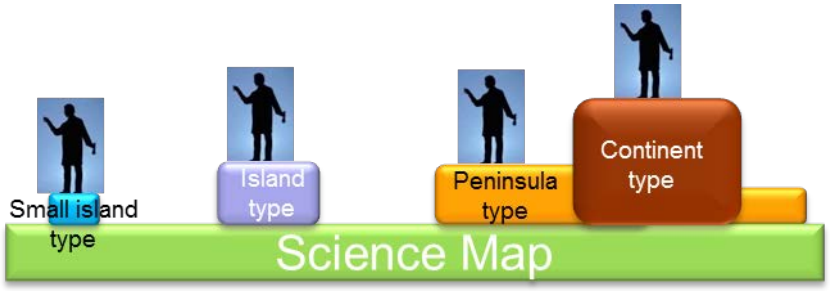


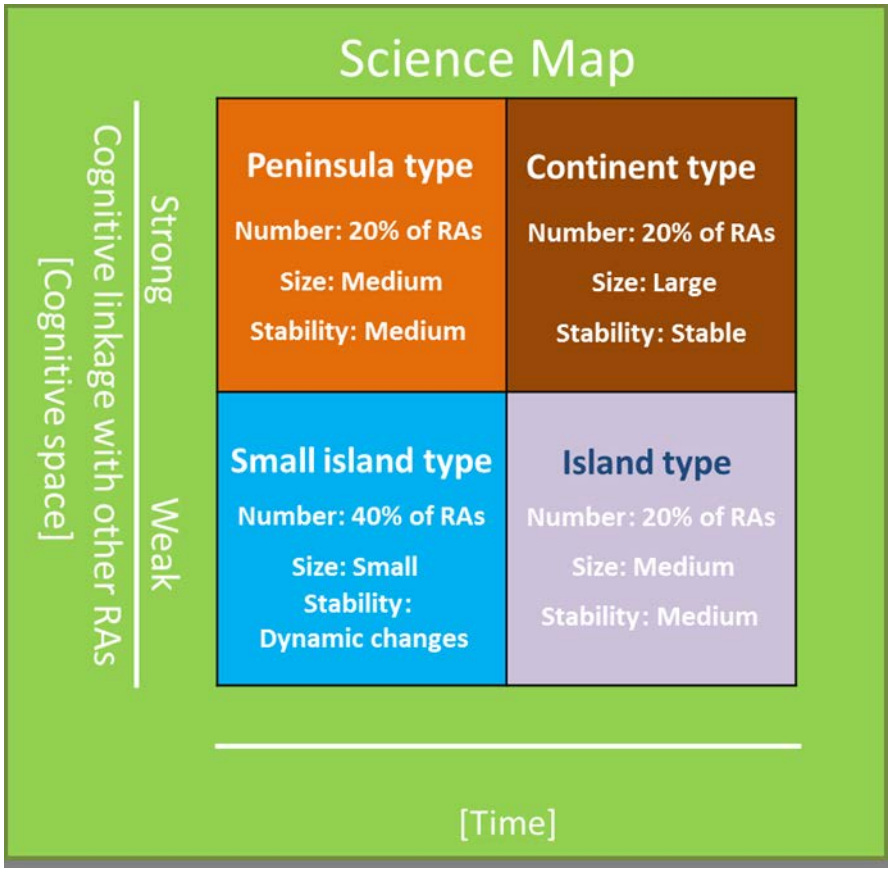
Data: NISTEP conducted analysis and visualization (Science Map visualizer) based on ESI research front data (NISTEP version) by Thomson Reuters.

Categorizing Research Areas Using the Sci-GEO Chart

Sci-GEO Chart

(Chart represents the geographical characteristics of the research areas on the Science Map)





(Note 1) Linkage: A research area (RA) is said to be linked to another RA if the degree of normalized co-citation is 0.02 or more. The linkage is considered as strong if there are three or more links. The linkage is considered weak if there are two or fewer links.
(Note 2) Continuity: Continuity requires 20% or more core papers overlapping between research areas in the Science Maps being compared.
(Note 3) Figures appeared in above table show the number of RAs and characteristics in Science Map 2012.

Data: NISTEP conducted analysis and visualization (Science Map visualizer) based on ESI research front data (NISTEP version) by Thomson Reuters.

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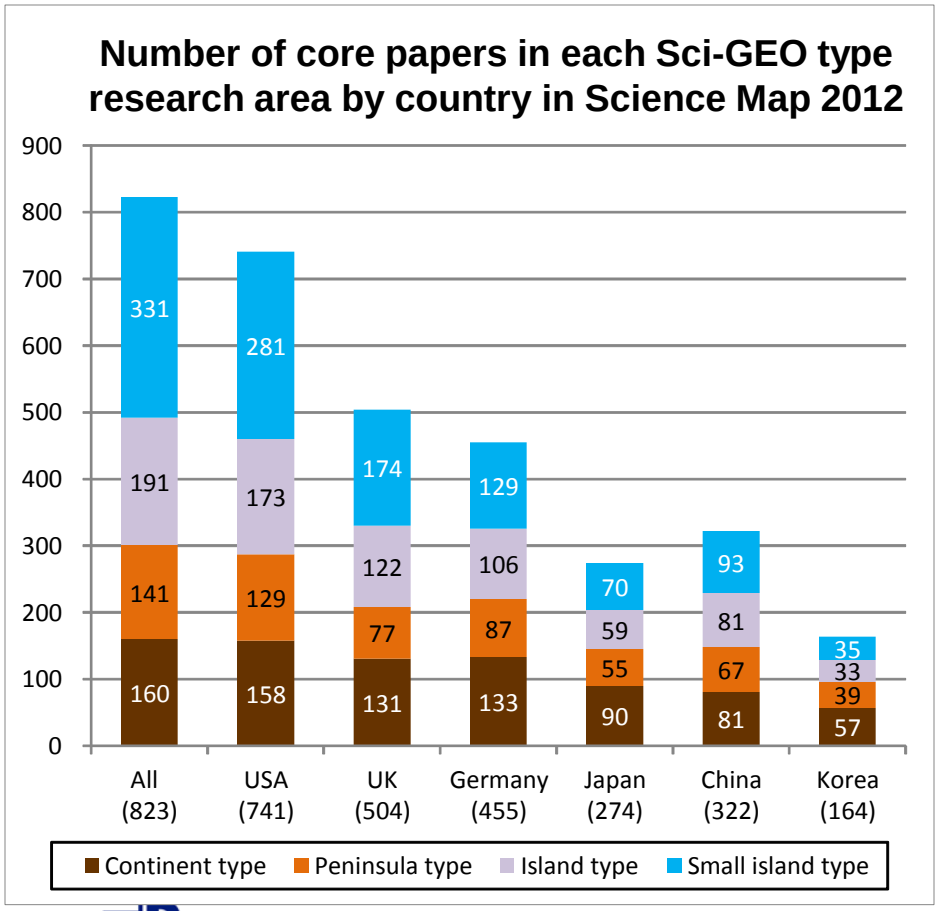
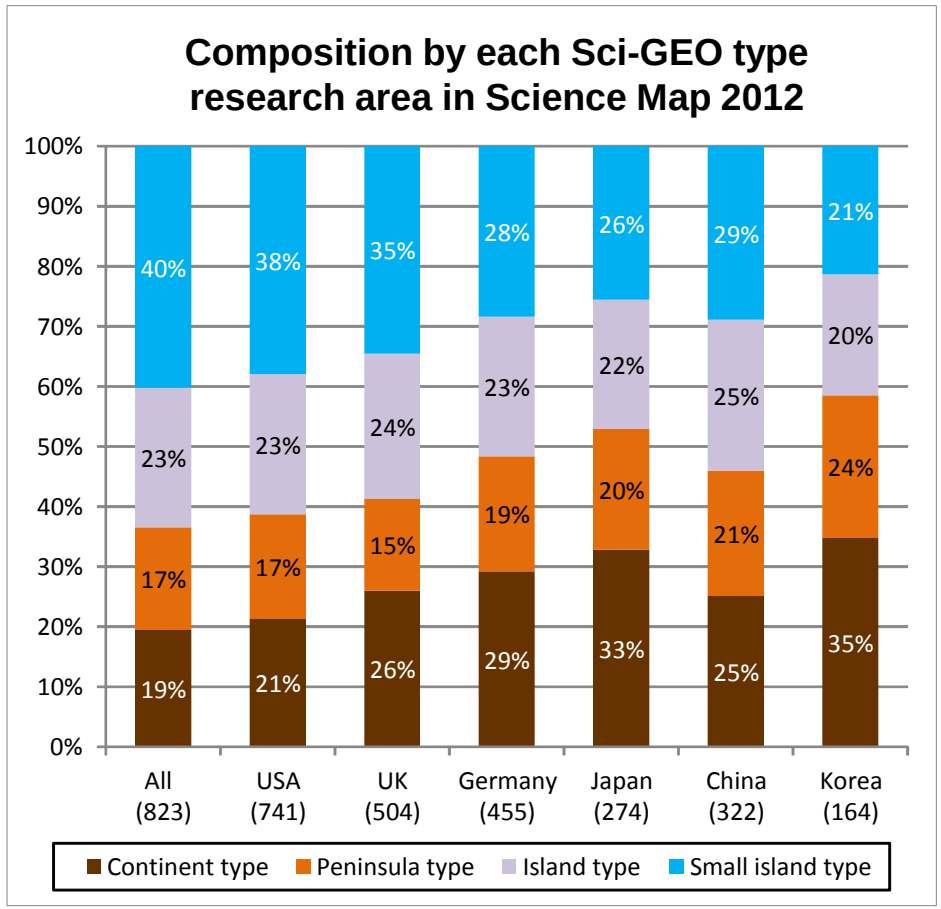
Comparison of Japan and Benchmark Countries by Sci-GEO type





Data: NISTEP conducted analysis and visualization (Science Map visualizer) based on ESI research front data (NISTEP version) by Thomson Reuters.

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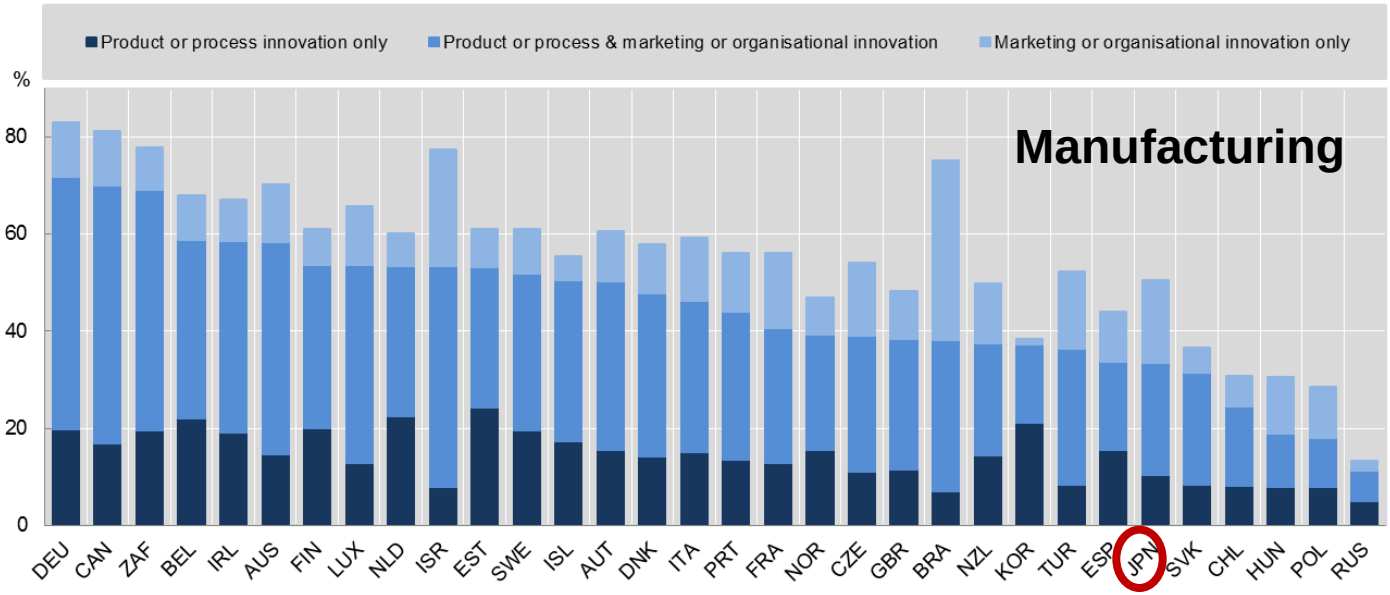
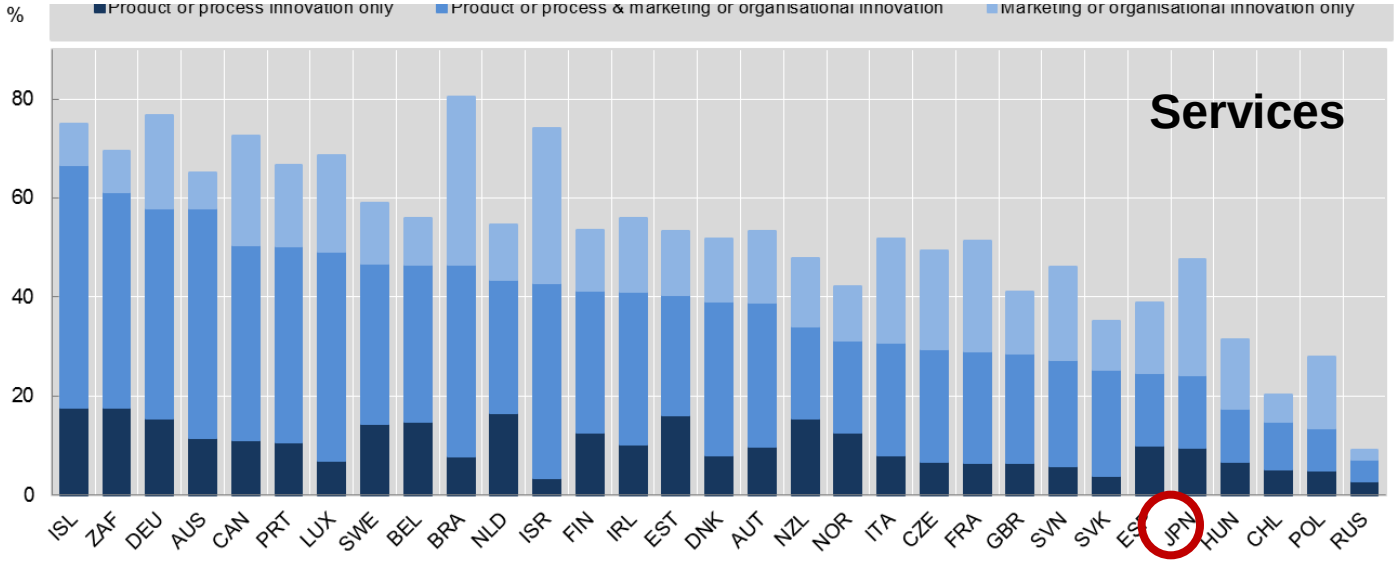
Japanese National Innovation Survey (J-NIS)

- NISTEP has conducted J-NIS in 2003, 2009 and 2012.
- "Comprehensive Strategy on Science, Technology and Innovation 2013" (June 2013; Cabinet Decision) requires data on firms' innovation activities
  - "It is necessary to continuingly conduct investigation and analysis of innovation creation conditions, obstructing factors, environment, etc., at companies, using methods that also enable international comparisons."
- Cooperation with OECD/NESTI and UNESCO/UIS activities
  - A revision process for the latest version of Oslo Manual (published in 2005)
  - A microdata project "Innovation in Firms" (published in 2009) of OECD innovation Strategy
  - Biennial reports on Science, Technology and Innovation policy and indicators, "OECD Science, Technology and Industry Scoreboard" and "OECD Science, Technology and Industry Outlook"
  - NESTI's current review process on innovation survey according to Oslo Manual (ex. collecting methodology / information of the survey of each country
  - OECD Innovation Statistics (online database)
  - UNESCO/UIS Measuring Innovation (Forthcoming; report or online database)

Innovative firms in OECD member countries
(OECD Science, Technology and Industry Scoreboard 2013)

- The rate depends on composition of industry in each country.
- Japanese respondents tend to perceive “innovation” in narrower sense than western countries.





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Survey on Research Activities of Private Corporations in Japan 2013, NISTEP

- Enquiry Target
  - corporations in Japan
  - capital> 100M yen
  - engaged in R&D
  - 3,462 corporations
- Response rate
  - 47.5 %
- Enquiry Period: November 2013
- R&D activities in FY2012 was surveyed.

(Formal report of the survey has been published in Sept. 2014, with Japanese full-version available on our Website.)

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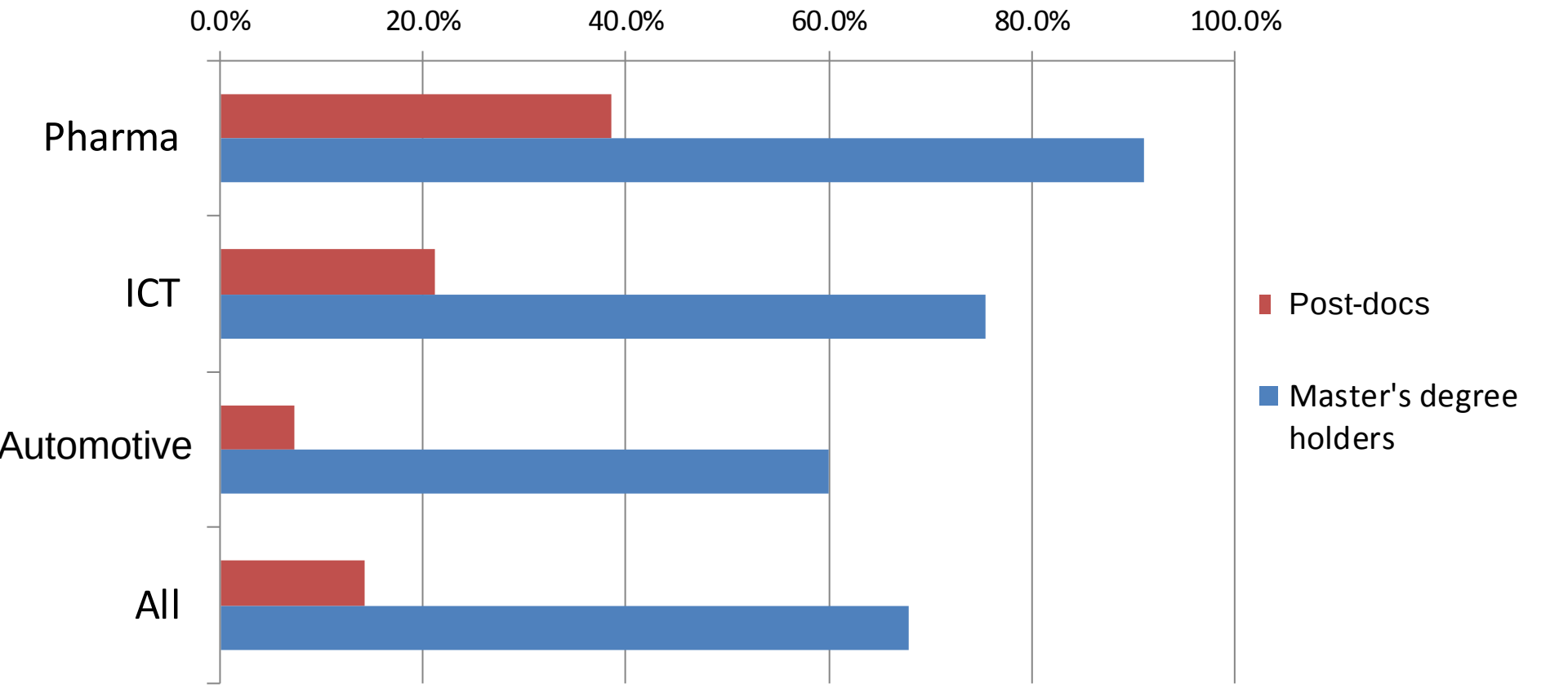
Employment of Highly-skilled Talents by Private Corporations in Japan

Percentage of corporations that have hired one or more post-docs or new master's degree holders in the past five years



- Pharma ranked highest of all 41 industries for both the number of post-docs and the number of new master's degree holders hired.

- Source: Survey on Research Activities of Private Corporations in Japan 2013 (NISTEP Report No.160, Sept. 2014 [Japanese version])

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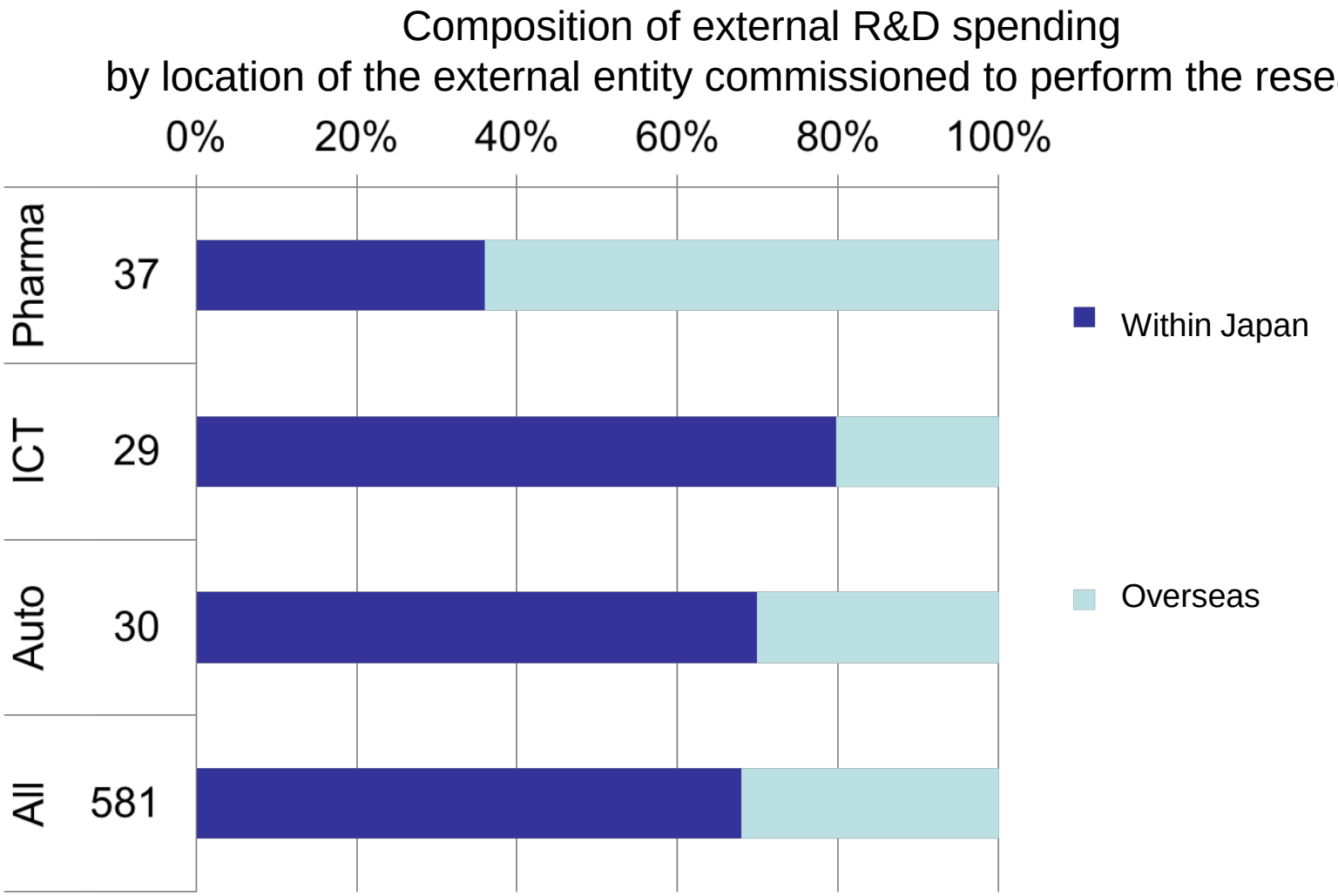
Locations of Commissioned R&D by Private Corporations



- Pharma shows the opposite composition to that of “All” industries.

* Above figures show the average composition, which is the value obtained by dividing the total R&D expenses of the corporations in each industry by the total sales of those corporations.

- Source: Survey on Research Activities of Private Corporations in Japan 2013 (NR #160)

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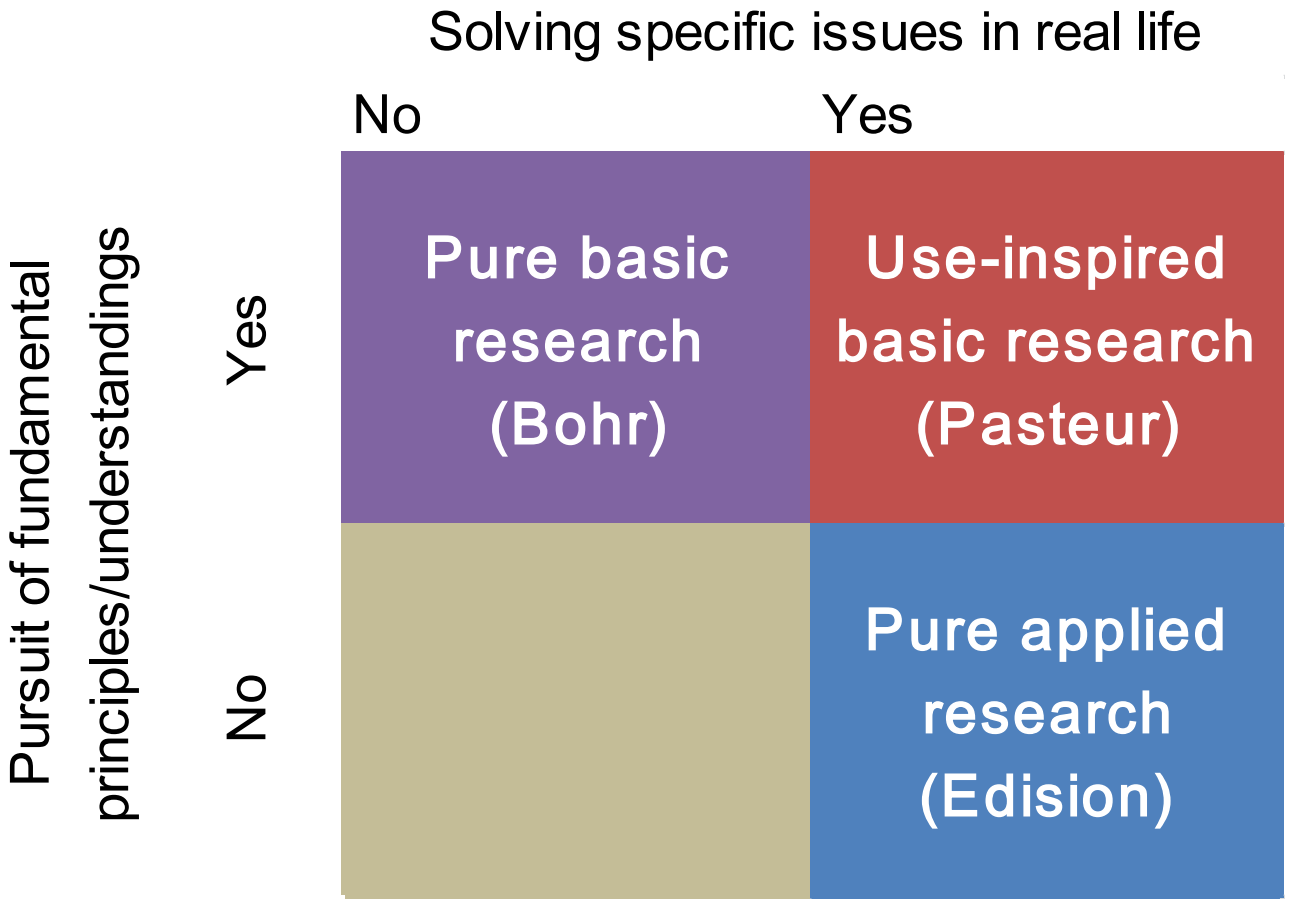
(3) Exploring the effects of the motivation of a research project : Significance of Use-inspired basic research (Stokes Quadrant – Pasteur-type research)



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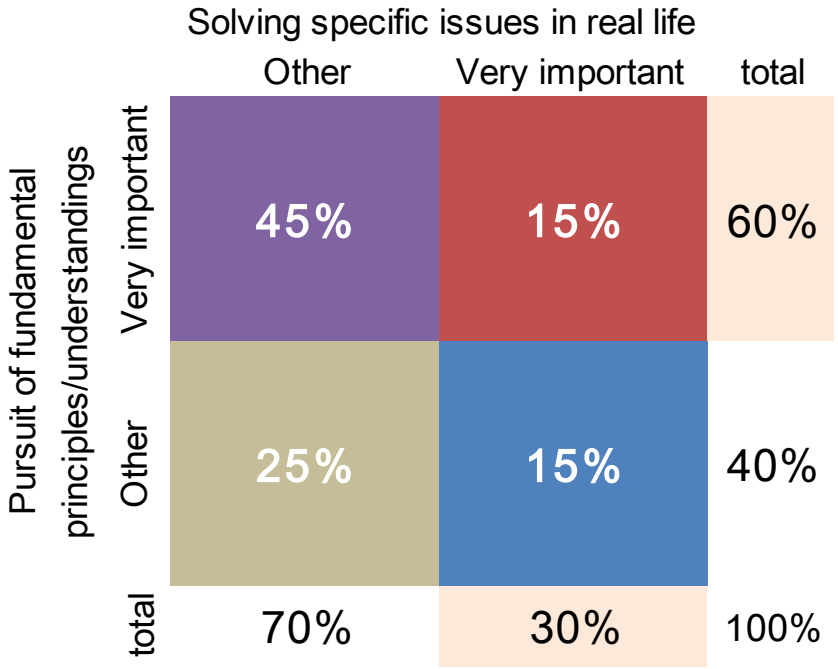
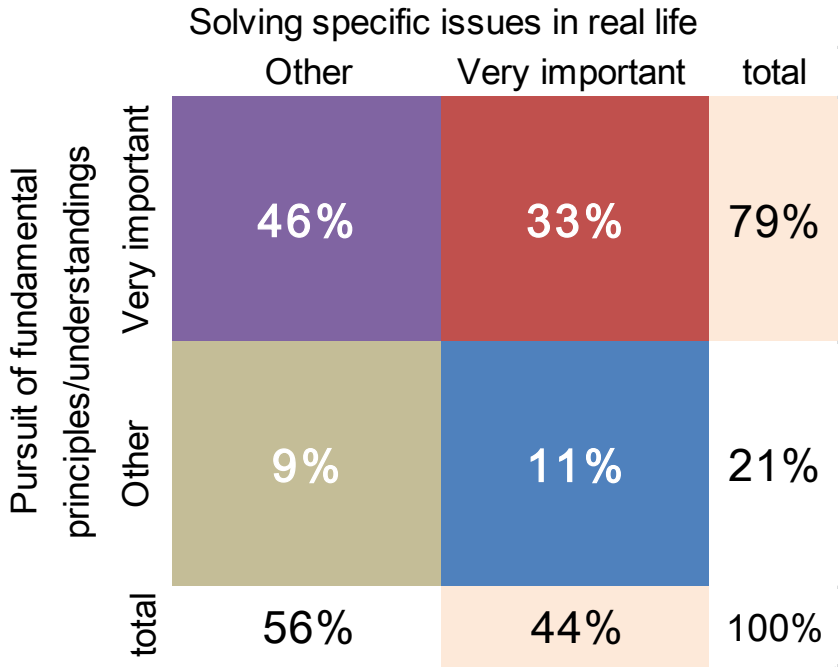
Distribution of the H projects by quadrant (JP vs. US)

(a) Japan



(b) USA



Note: Results weighted by field.

- Source: Presentation by Masatsura Igami, International Workshop on Science Sources of Innovation, March 2014 (Hitotsubashi Univ. and NISTEP)

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Implication to S&T policy especially in Japan (tentative)

- System that increase motivation of research projects is needed.
- Support of research projects (and researchers) should be made in consistent with the motivation of research.
  - Primary target of internationalization of research would be Bohr-type research, not Edison-type research.
- Various indicators should be used for monitoring of research projects.
  - Putting to too much weight on the indicators of papers and citations would discourage Edison-type research.

- Source: Igami, M & Nagaoka, S, “Exploring the effects of the motivation of a research project on the research team composition, management, and outputs”, presentation at STI2014, Sept. 2014, Leiden, the Netherlands

III. NISTEP's Key Mission to contribute to Evidence-based STI Policy-planning toward the Future

(1) Establishing data & information infrastructure for SciREX (Science for RE-designing STI Policy)

(2) Survey of the careers of doctoral program graduates

(3) The 10th S&T Foresight: Scenario planning to address challenges in the future

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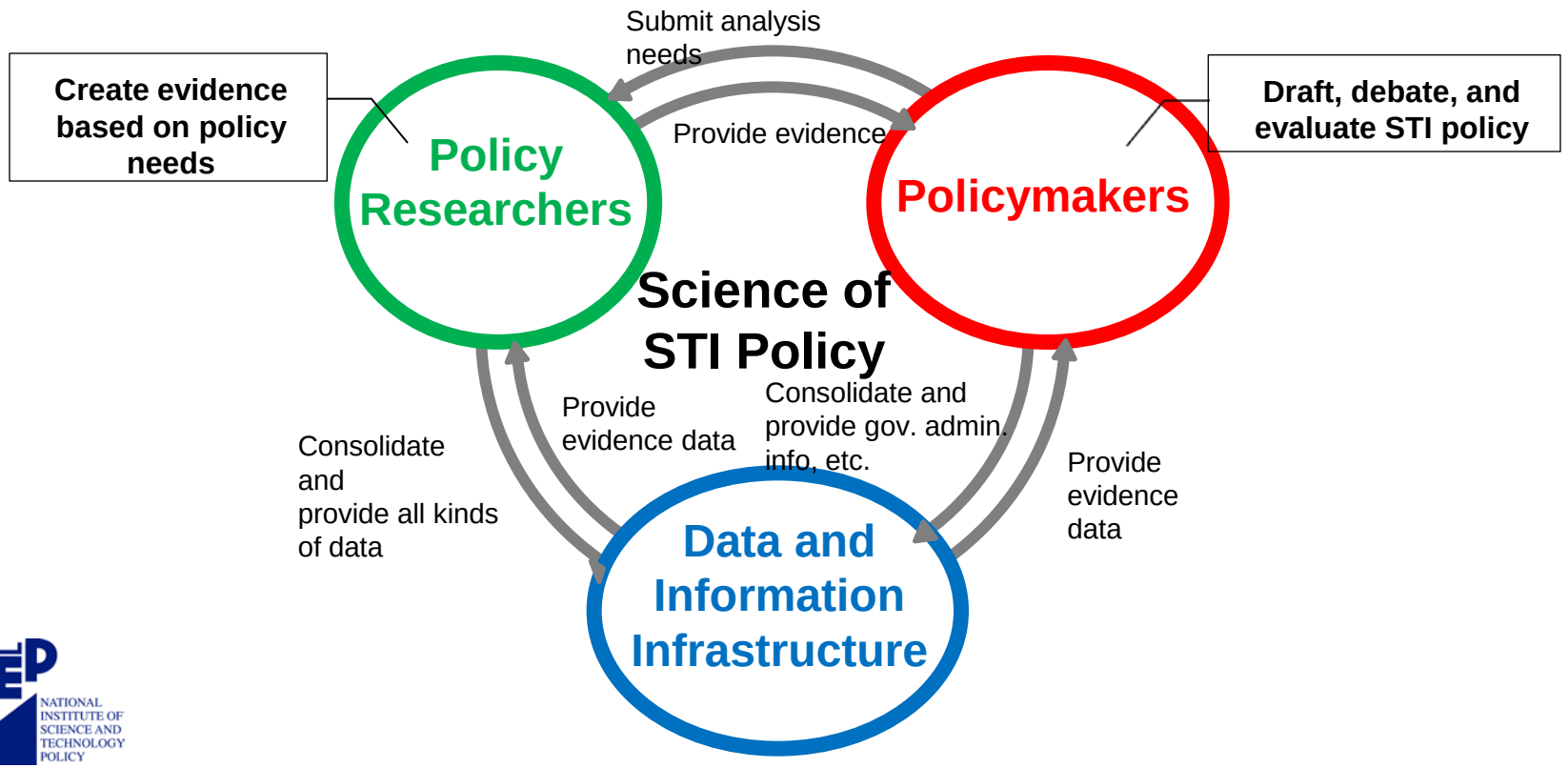
(1) Establishing Data & Information Infrastructure

- Based on the 4th Science and Technology Basic Plan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) is promoting the program titled "SciREX: Science for RE-designing Science, Technology and Innovation Policy". It aims to promote evidence-based policymaking and the incorporation of policy evaluation and verification in policies and also to establish a process for evaluating policy prerequisites and reflecting the results in policymaking.
- As part of the program to promote the "Science of Science, Technology and Innovation Policy," NISTEP has since FY2011 been developing data and information infrastructure as knowledge infrastructure for the systematic and ongoing collection of data and information that can be used in forming STI policies and in surveys, analyses, and research.

Position of the Data & Information Infrastructure in SciREX Program



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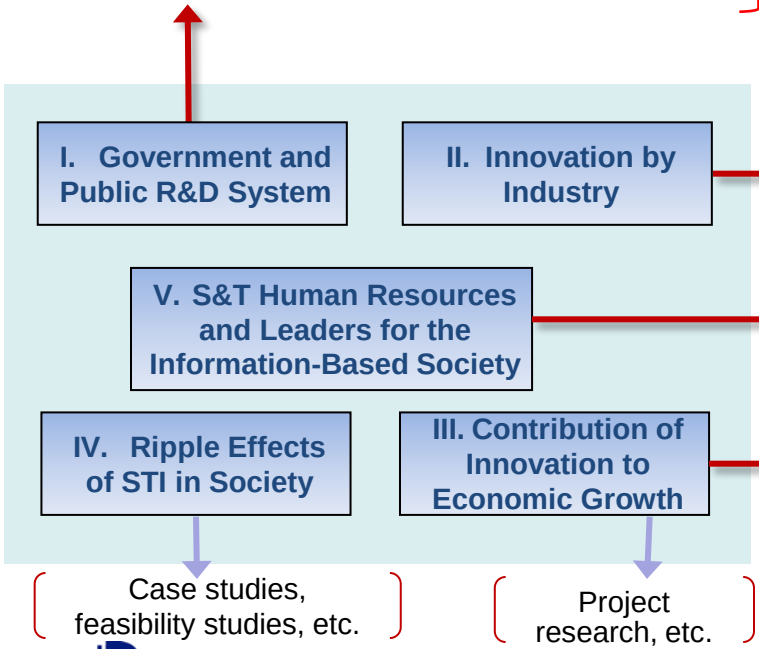
Current Status of the Data and Information Infrastructure

Infrastructure for Science, Technology and Innovation (STI) Research

- Database of S&T Resource Allocation
- Database of Key S&T Policies

- NISTEP Dictionary of Names of Universities and Public Organizations
- Scopus Organization Name Variation Table
- Concordance Table between Scopus and NISTEP Dictionary of Names of Universities and Public Organizations
- WoS Organization Name Variation Table

Legend
- ■ Released
- □ Preparing for release
- ➢ Under development



- ➢ Technology Impact Analysis Using Input-Output Table

- NISTEP Dictionary of Corporate Names
- Correspondence Table between JPO Patent Database and NISTEP Dictionary of Corporate Names
- □ Japanese National Innovation Survey Data

- ➢ Database of PhD Holders

Databases by Region/Industry
- Rate of Technological Knowledge Obsolescence
- Corporate and Public R&D Stock
- Corporate and Public R&D Spillover
- Technological Accessibility between Industries
- Technological Accessibility between Industries by Scientific Field
- Productivity by Region and Industry
- Japanese National Innovation Survey (only tabulations by industry)
- ➢ Status of Job Creation by Corporations

Tools for Providing Evidence for Policymaking

- Information Retrieval System for NISTEP Fixed-Point Observation Surveys
- Database for Basic Search of Free Descriptions in NISTEP Fixed-Point Observation Surveys
- Dictionary for Text Mining of Free Descriptions in NISTEP Fixed-Point Observation Surveys
- Science and Technology Indicators: HTML Version
- System for Displaying Maps of Data on International Co-authorship of Research Papers
- □ System for Displaying Maps of Data on International Mobility of Researchers
- Information Retrieval System for Japanese Delphi Surveys

General Data and Information Infrastructure

- Information Retrieval/Provision System for All NISTEP Reports (Repository)
- Compilation of Links to Data and Information Infrastructure in Japan and Overseas

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Network of Organizations Involved in the Data and Information Infrastructure

- Objective: Create a network of R&D funding organizations and organizations holding relevant data.
- Achievements in FY2014: Held 3 meetings to discuss and conclude consensus paper / proposals on setting a common platform of R&D funding / output information, for the drafting process of 5th S&T Basic Plan.

Participating Organizations

- National Institute of Informatics (NII)
- Japan Science and Technology Agency (JST)
- National Institution for Academic Degrees and University Evaluation (NIAD-UE)
- Japan Society for the Promotion of Science (JSPS)
- Research Institute of Economy, Trade and Industry (RIETI)
- New Energy and Industrial Technology Development Organization (NEDO)
- National Institute of Information and Communications Technology (NICT)
- National Agriculture and Food Research Organization (NARO)
- National Institute of Biomedical Innovation (NIBIO) (*till the end of FY2013)

Key Discussion Topics

- Potential for consolidating and standardizing R&D funding information (introduction of universal citation code, etc.)
- Potential for responding to the review of the Science and Technology Basic Plan

* The competitive research funds allocated by the organizations participating in the Network listed above (underlined) make up about 90 % of total competitive funds in Japan (FY2013: 409 billion yen).

Source: Tabulated by NISTEP using "Table 2-5-2: List of Competitive Funds" of the White Paper on Science and Technology 2014*. Includes programs jointly sponsored with the Ministry of Education, Culture, Sports, Science and Technology (MEXT), including Grants-in-Aid for Scientific Research and the Core National Research & Development Promotion programs.*

Funding History for the Laureates of Nobel Prize in Physics 2014

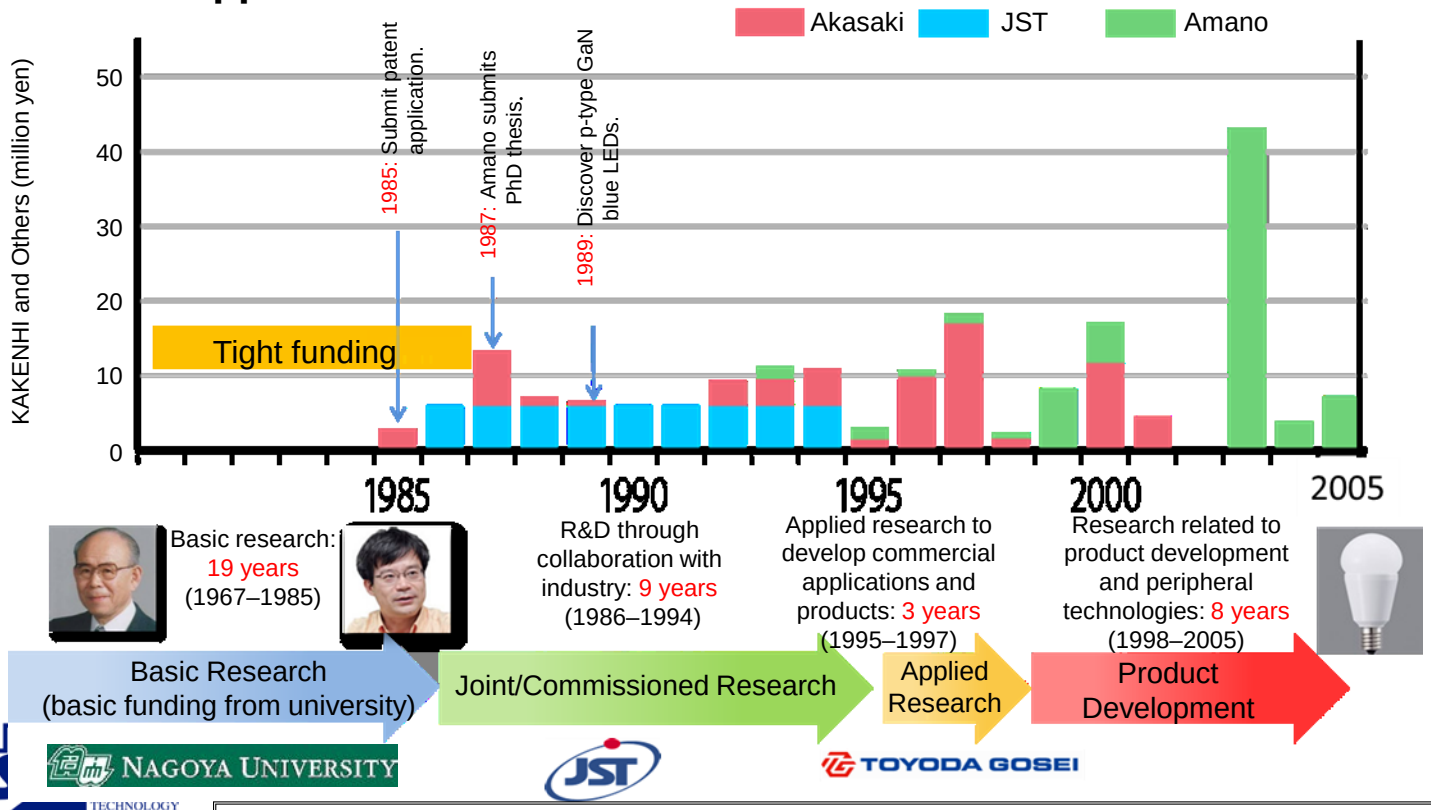

Isamu Akasaki


Hiroshi Amano


Shuji Nakamura

- Isamu Akasaki, University Professor at Meijo University and Distinguished Professor at Nagoya University; Hiroshi Amano, Professor at the Nagoya University Graduate School of Engineering; and Shuji Nakamura, Professor at the University of California at Santa Barbara, were awarded the Nobel Prize for Physics this year.
- The Prize was awarded in recognition of the three scientists' research related to the discovery of blue light–emitting diodes (LED).
- Full-fledged discussions are underway from this fiscal year to create the 5th Science and Technology Basic Plan (FY2016–FY2020) with an eye to further strengthen Japan's S&T.

Support from KAKENHI and Others

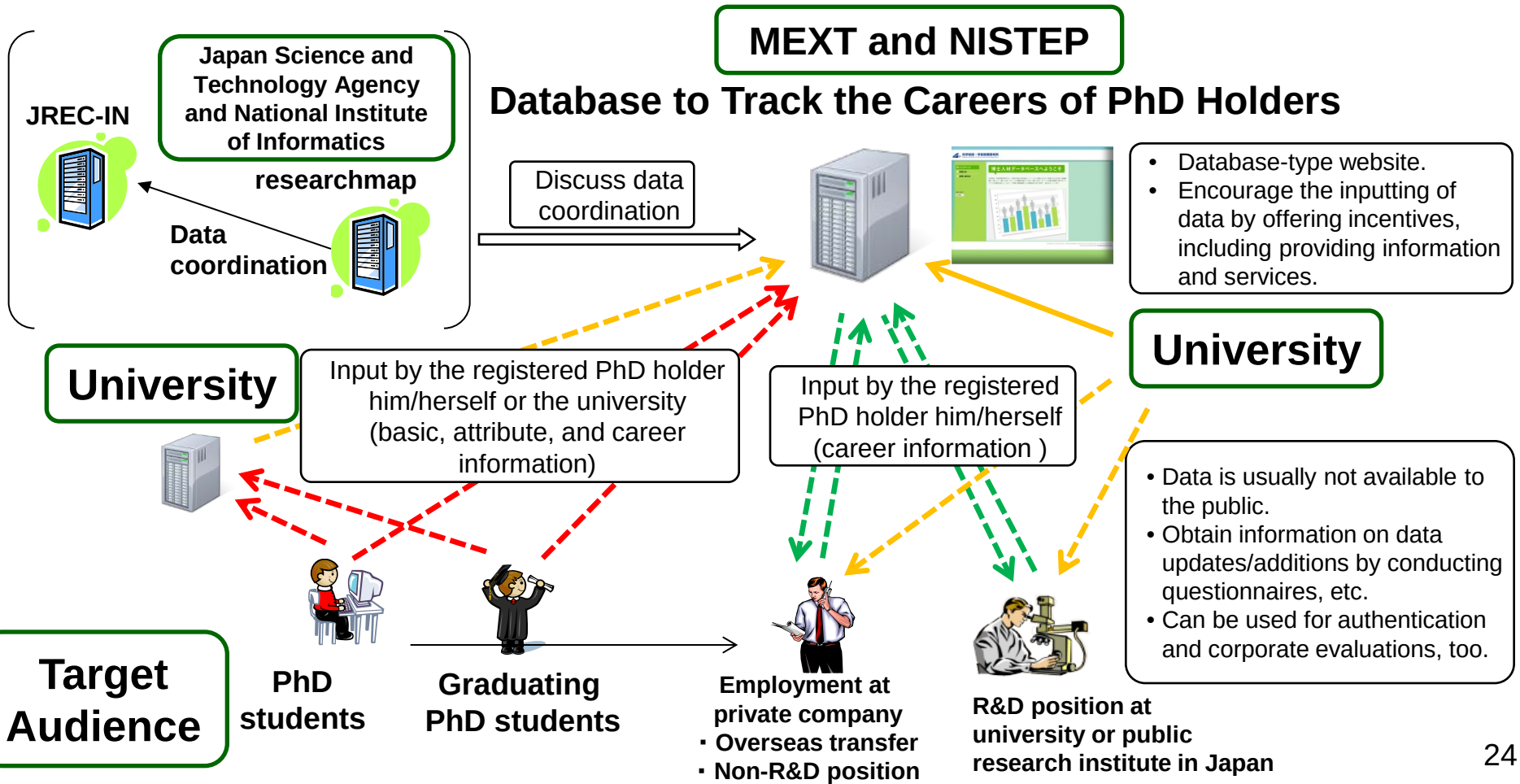


Source: Presentation of Prof. Hiroshi AMANO at CSTI Plenary Session, 22 Oct. 2014 (Translated by NISTEP)

(2) Building Database to Track the Careers of PhD Holders

Objective in Building the Database

- Graduate schools are being called to train up PhD holders who can handle globalization and industry needs.
- Obtaining career information on PhD holders after graduation is limited. There is no framework for ascertaining how PhD holders are contributing to society as their careers develop.
- In collaboration with universities and related organizations, NISTEP is developing the Database to Track the Careers of PhD Holders as information infrastructure that can monitor the attributes of PhD holders and trace the development of their careers after graduation.



Plan for Building Database to Track the Careers of PhD Holders

FY2011 | FY2012 | FY2013 | FY2014 | FY2015 – FY2020

Concept Design

System Design and Building

Collaboration with Universities toward Trial Operation of System

Create tie-ups with some of the universities selected for government subsidy programs and discuss with them trial operation of the system

System Development with 12 Universities and Pilot Operation

Pilot version of database

Expand the number of participating universities and aim for full operation as soon as possible.

Acquisition of Career Information through Autonomous Operation of System by Universities

Full operation of database

International Symposium on Ascertaining Career Status of PhD Holders. (Feb. 27, 2012)

Symposium on PhD Holder Database. All Japan-based universities with PhD programs thereby informed about database. (June 2, 2014)

First Conference on Pilot Operation of PhD Holder Database. Attended by 12 universities. (Aug. 7, 2014)

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(3) The 10th S&T foresight

History of S&T foresight and the development of STI policy in Japan

1970-80s
- **Catch up process**
- Bottom-up decision making
- Consensus among sectors

1990s
- **Transition phase**
- Moderate link between S&T policy and foresight

EU, APEC, UK, Germany, Korea

2000-
- **Strong prioritization**
- Top-down decision making
- Link between S&T policy and foresight

Russia, Sweden, China

2010-
- **Back casting**
- Social problem-solving

2015-
- **Integration**
- S&T policy and innovation policy

1995
S&T Basic Law

1996-2000
The 1st S&T Basic Plan

2001-2005
The 2nd S&T Basic Plan

2006-2010
The 3rd S&T Basic Plan

Innovation 25

2011-2015
The 4th S&T Basic Plan

Dream vision 2020

2016-2020
The 5th S&T Basic Plan

1971 The 1st Technology Foresight
1977 The 2nd Technology Foresight
1982 The 3rd Technology Foresight
1987 The 4th Technology Foresight
1992 The 5th Technology Foresight
1997 The 6th Technology Foresight

Delphi

2001 The 7th Technology Foresight

Delphi Needs survey

2005 The 8th S&T Foresight

Delphi Needs survey

Bibliometrics Scenario planning

2010 The 9th S&T Foresight

Delphi Scenario planning

Regional survey

2014-15 The 10th S&T Foresight

Vision Delphi

Scenario planning

Process for 10th S&T Foresight Survey : Integration of Bottom-up & Top-down approach

Vision

Nov. 2013 – Mar. 2014
Creating vision for Future Society

- Realizing the affluent society
- Elaborating the roles of STI to achieve the vision

S&T

April. 2014 – Oct. 2014
The 10th S&T foresight (Delphi survey)

- Selecting promising, emerging technological issues
- Evaluating the above issues

Scenario

Nov. 2014 – Mar. 2015
Scenario planning for social problem solving

- Providing STI policy options

Structure of 10th S&T Foresight Survey

Request for cooperation / Participation

NISTEP

Experts Network

Academic Societies, Associations

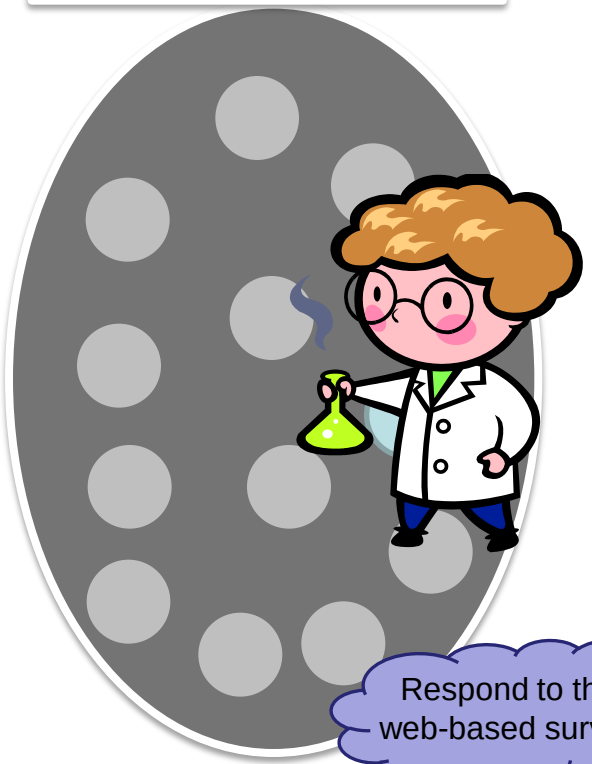
Experts

S&T Committees

- ICT / Analytics
- Health / Medical / Life science
- Agriculture / Foods / Biotechnology
- Space / Ocean / Earth / ST Platform
- Environment / Energy / Resources
- Materials / Devices / Processes
- Social Infrastructure
- Servitization / PSS (Product-Service Systems)

R&D Issues

Evaluation



Respond to the web-based survey

Vision Committee

Scenario Planning Committee

Input-Output analysis Team

Excerpts of Top 100 High Priority Issues

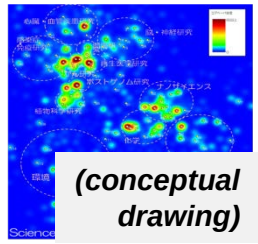
Field：Item	Issues
Social infra.: disaster prevention	Establishment of the reactor abolishment technology and radioactive waste disposal technology for 1 mega Kw-class nuclear reactors
ICT：HPC	Technology to increase the performance electricity ratio by a factor of a hundred to the current ratio on a very large scale super computer exceeding one million nodes and a big data IDC system
Health：medical equipment	Dementia care assistance system which can be easily introduced at low cost
ICT：ICT & society	A health care system that monitors the condition of patients in real time to provide optimal nursing or medical care at a low cost
Health：common disease	Preventive medicine to suppress the carcinogenesis from the pre-carcinomatous state
Health：regenerative medicine	Medical technology to regenerate the functions such as hearing and sight
Environment：resources	Mineral extraction and mining technology needed for extracting ocean mineral resources
ICT：software	Technology to develop software without security holes which allow remote exploitation
ICT：artificial intelligence	Independence support system enabling elders and handicapped people to have normal social life without the assistance by caregivers
Agriculture：fisheries & resource conservation	Technology to predict the variation in sardines, tuna, and other major fishery resources under different harvesting and long-term environmental conditions, as well as technology for the proper management of fishery resources based on this prediction technology
Agriculture：fisheries & environmental conservation	Technology to remove radioactive substances in order to revitalize fishing in coastal areas

Field：Item	Issues
Agriculture：agriculture & crops development	Crops that can be expected to produce a good harvest even in environments generally unsuitable for farming such as deserts (arid regions), etc.
Science platform：synchrotron radiation	Technology to observe the local structure and electronic state which are the essential information for the elucidation of expression mechanism and the control of the functions of functional materials in nanometer-scale and femtosecond order
ICT：theory	Development of data utilization techniques with theoretically guaranteed preservation of privacy
Earth：Earth	Assessment of degree of urgency for all the active volcanoes to find out the ones likely to erupt next
ICT：Network	Flexible network and mobile terminal technology which normally works to ease congestion and improve the fault tolerance of the network, but when a disaster strikes it is immediately expanded in disaster areas, supporting rescue operations and enabling people to use voice, video, and packet communications without interruption
ICT：cyber security	A low cost, easy-to-use, secure personal authentication system which can be used with confidence even when accessing many different websites over a long period of time
Social infra.: car /railroad /ship /aviation	Low-emission and energy efficient aircraft to realize reducing noise at the takeoff and landing as well as the emission gas during the flight, and to achieve lowering the frictional resistance on the body and improving the combustion efficiency of the engine
Environment：global warming	Technology to predict the impact to the food production by the climate change
Agriculture：common	Real-time mountain weather forecast and disaster risk assessment using data from satellites, meteorological observations, etc.
Material：application（ICT /nanotech）	Integrated circuit technology to realize the performance level similar to the existing super computer with one chip by improving the information processing ability without increasing the electricity consumption per unit area

Future Outlook of NISTEP's Research for Evidence-based Policy Planning

(1) Projection mapping of strategic R&D areas and star researchers that will pioneer the future (*micro level*)

- Visualize and identify emerging and "hot" research areas and innovation fronts.
  - Science Map and link-mining



(conceptual drawing)

(2) Analysis / visualization of policy & program outcomes on axes of time and space by linking people, funding, and outputs (*micro / meso levels*)

- Build a system for the spatio-temporal analysis of R&D resources and results.
  - **Integrated use of the Database of PhD Holders (people) and the Network of Organizations Involved in the Data and Information Infrastructure (funding/results)**
  - → (ex.) "Research productivity" by actor (university/organization, geographic region, academic field); analysis of economic and social impact; international mobility of human resources

(3) Development of a "20XX Vision" for the YY policy area (*macro level*)

- Build a system for the meta-level utilization of S&T Foresight Survey and the scenario planning in STI policy-making process.

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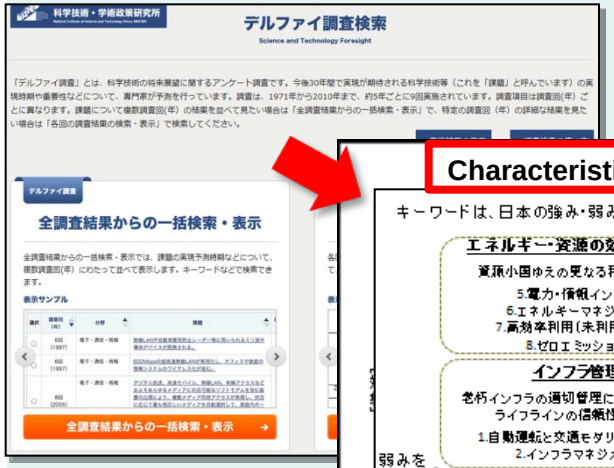
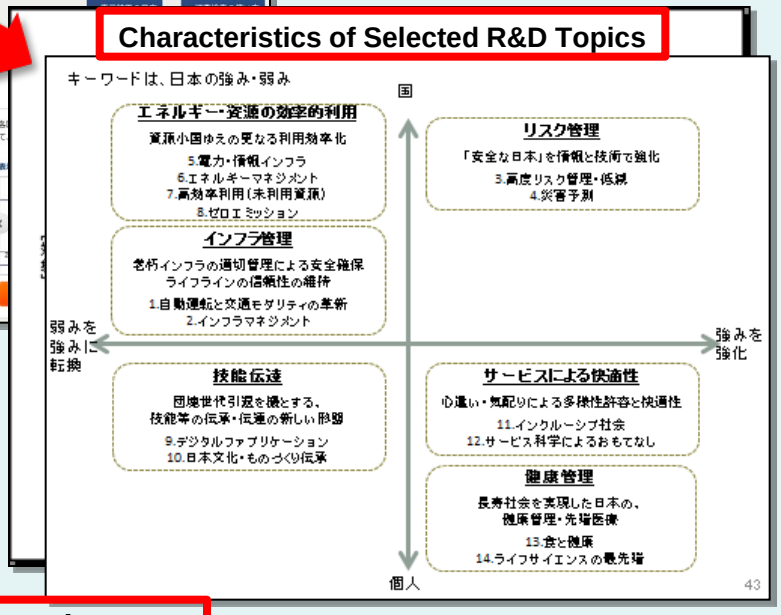
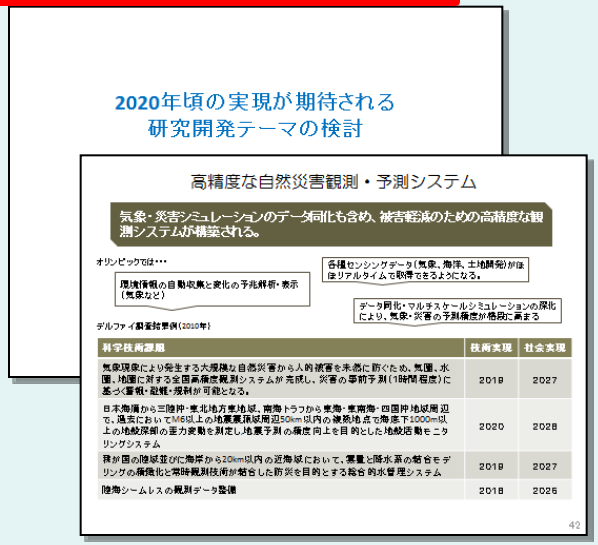
Contribution to the Formulation of a Future Vision for Public Policy: Development of a “20XX Vision” for the YY Policy Area (Macro Level)



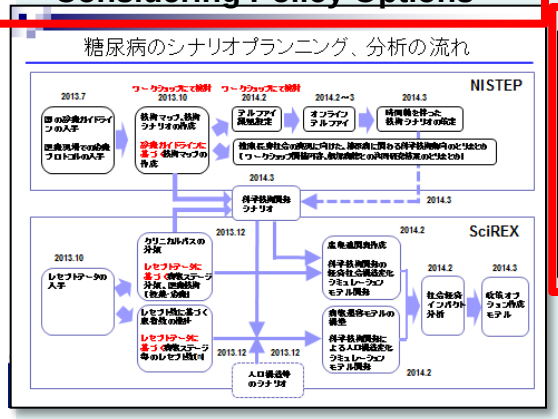


Japan Vision 2020 by MEXT



2030 Issues
(provision of information to Diet member study groups)

Trial Use of SciREX in Considering Policy Options



Contribute to the formulation of a vision for 2020 and 2030 for integrated policy areas and composite policy areas that are the basis for backcasting.

Thank you so much for your attention!

Please visit our Website:
http://www.nistep.go.jp/en/

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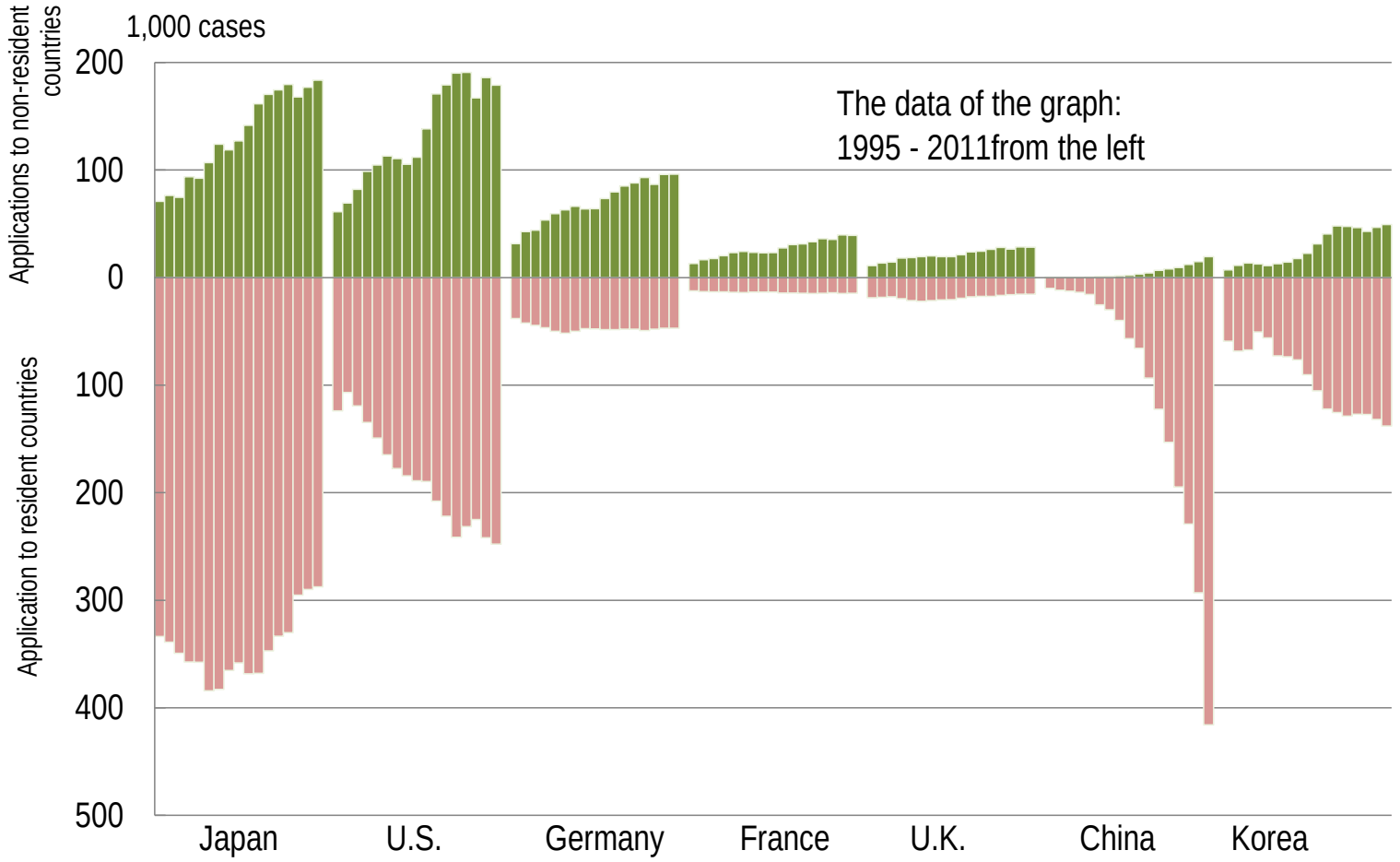
[Reference Slide #1]

The numbers of patent applications from main countries (1995–2011)



– Source: NISTEP, Japanese Science & Technology Indicators 2013, Research Material–225, Aug. 2013

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[Reference Slide #2]

Science Map

- Purpose
  - To capture the evolving nature of science
- Methodologies
  - Two-stage clustering of the top 1% highly cited papers using co-citation analysis (Highly cited papers → Research Fronts → Research Areas).
  - Mapping of research areas using a force-directed-placement algorithm.
  - Content analysis of selected research areas by experts.
- Application
  - Identifying “hot” research areas in science
  - Tracking the changing nature of research areas
  - Visualizing statistical data on the map

- Results of Science Map 2008 were cited in OECD innovation strategy (Measuring Innovation: A New Perspective).

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[Reference Slide #3]

Japanese National Innovation Survey (J-NIS)

- NISTEP has conducted J-NIS in 2003, 2009 and 2012.
- Purpose
  - Examine status and trends of firms' innovation activities quantitatively in order for the government to make science, technology and innovation policies
- Data collected in the latest survey (J-NIS 2012)
  - Product innovation
  - Process innovation
  - Organizational innovation
  - Marketing innovation
  - Objects of each innovation
  - Activities for product or process innovation
- Method for collecting internationally comparable data
  - Oslo Manual: OECD and Eurostat's internationally standard guideline for collecting and interpreting innovation data referred by about 80 countries / regions
  - Methodology and questionnaire of EU Community Innovation Survey often referred in international comparison analyses of OECD

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[Reference Slide #4]

Hitotsubashi-NISTEP-GeorgiaTech scientists survey

Population of the survey

- Articles and letters in the Science Citation Indexes-Expanded (Thomson Reuters)
- Time window: 2001 – 2006 (database yr.)
- 22 fields in the ESI
- The papers of multidisciplinary field were reclassified based on the backward citations.

Questionnaire

- Inputs
- Research team
- Motivation and process
- Knowledge source and management
- Research Environment
- Personal Environment
- Outputs
- Commercialization

Identification of possible focal papers

- Highly Cited Papers *(H Projects)*
  - Top 1% highly cited papers in each journal field and in each database year (approximately 3,000 in total).
- Normal Papers *(N Projects)*
  - Randomly selected papers in each journal field and in each database year from the population of the survey (approximately 7,000).

Response rate

Survey was conducted in JPN and USA

- JPN: 27.2% (2,081/7,652)
- USA: 26.3% (2,329/8,864)

– Source: Presentation by Masatsura Igami, International Workshop on Science Sources of Innovation, March 2014 (Hitotsubashi Univ. and NISTEP)

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