Research Material No. 178

# Analysis on research activities in developing countries and international networking of researchers

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JAPAN

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## 1. Background and objectives of the survey

Researchers in developing countries, mostly in Asia, are expected to be promising partners when Japanese researchers try to expand their international academic network. Therefore, it is critical to understand the status of research activities in developing countries in order to promote Japanese academic activities. For this reason, the primary objective of this survey is to provide quantitative understanding of research activities in developing countries based on scholarly papers in the field of Natural Science, which is considered to be an index to measure the performance of research activities. With regard to researchers who stay in developing countries and publish papers in international journals, details of their activities (e.g., incentives to publish international joint papers or creation of international networking) have been little known so far. The second objective is to shed light on the reality of these research activities and identify the issues to be addressed so as to better understand the outcome of data analysis and learn how to collaborate with researchers in developing countries.

## 2. Structure of the survey

This survey is organized into two parts. The first part is based on a quantitative analysis on the data of scholarly papers, which consists of analysis on both worldwide studies and case studies targeting six developing countries. Specifically, we analyze the relationship between academic publishing and income level as well as the characteristics of international coauthorship based on Thomson Reuter Scientific's data (National Science Indicators, 1981–2006, Deluxe Version [hereinafter referred to as "NSI 2006"] and Web of Science [hereinafter referred to as "WoS"]), and then attempt to grasp the trends of countries holding the ownership of sources as well as tendency of coauthor countries, focusing on the six developing countries.

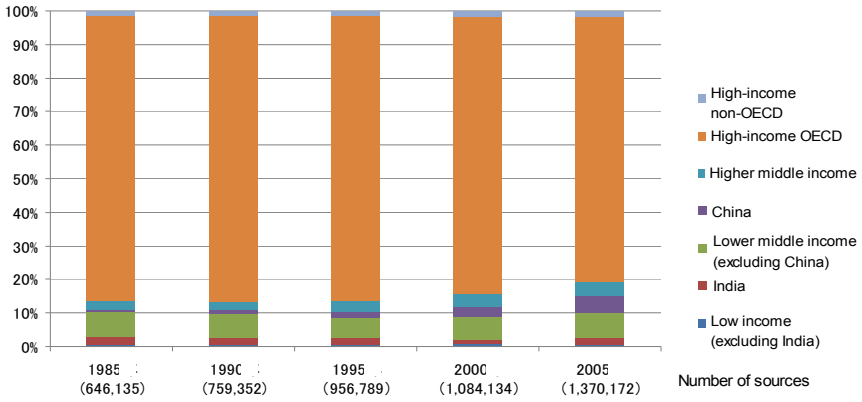
The second part is based on a qualitative analysis to shed light on research status in developing countries, which consists of an interview in the Philippines and Indonesia and its preliminary study in Japan. We will target researchers who stayed in those countries and published a substantial number of papers in international journals, and study the local research environment as well as the status and challenges in education for researchers.

## 3. Results of data analysis

### 3.1 Global academic publishing

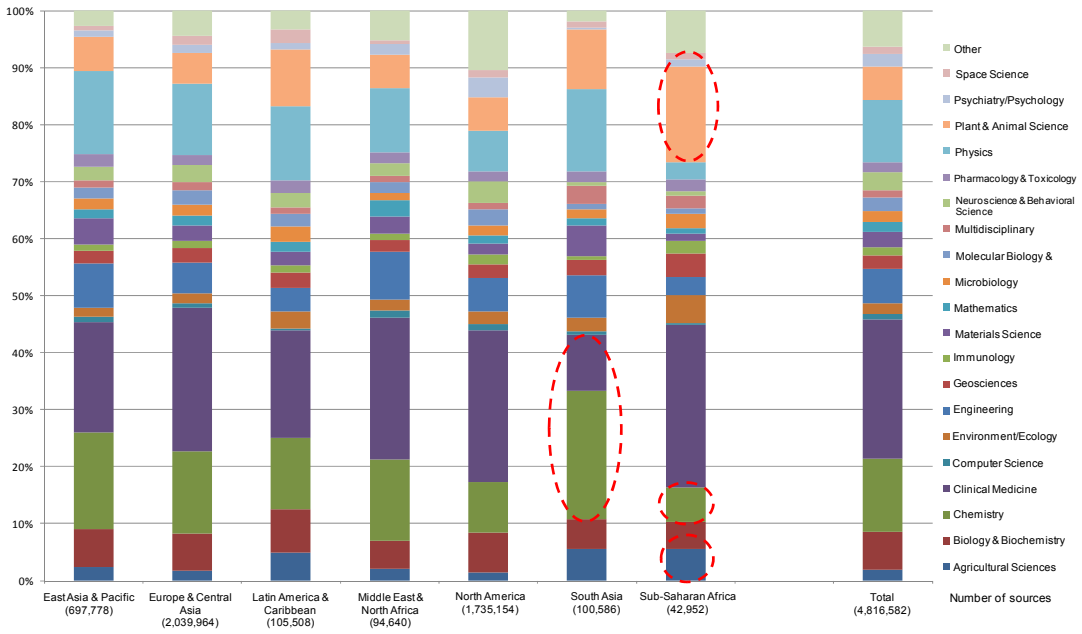
#### (1) Trends in the number of papers and the status of developing countries

Analysis on data of 161 countries between 1985 and 2005 from NSI 2006 shows that the number of papers increased in all income levels, regions, and countries (India and China are examined separately from the region categorized). The oligopoly of high-income countries slightly weakened (the number of articles increased nearly 3.8 times from 549,813 to 1,077,096 but the share decreased from 85.0% to 78.6%), while the share of middle-income countries including China increased. In the meantime, the share of low-income nations, which represent the lowest income bracket, dropped (i.e., the number of sources excluding India jumped about two times from 4,932 to 9,596, but the share decreased from 0.8% to 0.7%. In Sub-Saharan Africa, the number of articles increased approximately 1.8 times from 6,537 to 11,801, but the share declined from 1.0% to 0.9%).




## (2) Subject categories of sources by region

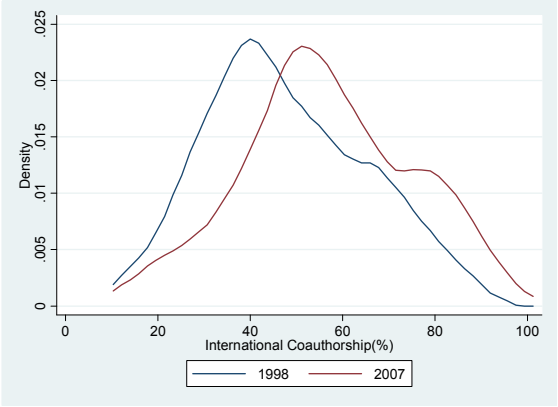
Each region shows a different category structure in academic publishing. In Sub-Saharan Africa, Agricultural Sciences and Plant & Animal Science accounts for a large share, while Chemistry and Physics is scarce, compared with sources of the whole world. In the meantime, South Asia shows that they have a large number of scholarly papers in the field of Chemistry but a small number in Clinical Medicine.



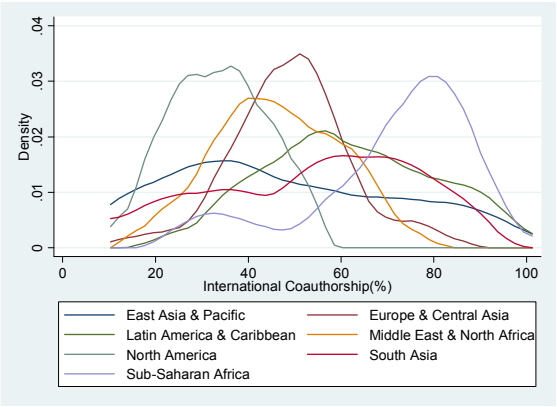

## (3) Characteristics of international coauthorship

An analysis of 103 countries using the WoS data calculated by the National Institute of Science and Technology Policy shows that the percentage of international coauthorship rose for these countries over the 10 years between 1998 and 2007. A trend of international coauthorship varies by region. According to regional analysis on international coauthorship by country and by year, Sub-Saharan Africa records almost 80% in the mode (the largest number of countries) , which is the highest among seven regions, while that of North America peaks at approximately 30%, which is the lowest. Europe and Central Asia peak at around 50% (see the main text for details).

Movements in the international coauthorship rate (1998 and 2007)

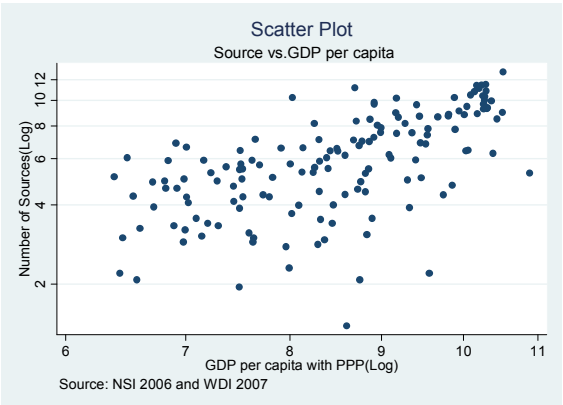



Distribution of the international coauthorship rate by region

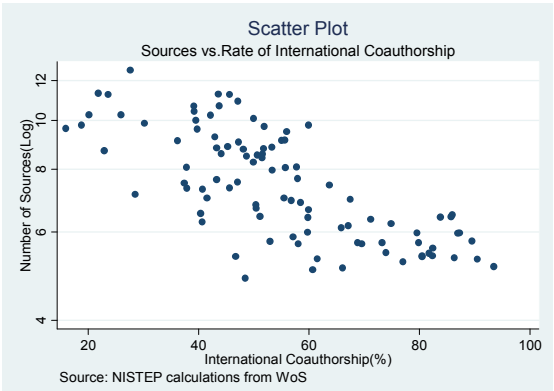



The following scatter plots show a positive correlation between the number of papers and GDP per capita, while negative correlation can be identified between the number of papers and the international coauthorship rate. There could be certain factors behind the relationships among the number of papers, income levels, and international coauthorship. For example, high income levels would activate research activities and as a result increase academic publishing. Furthermore, if a country publishes a large number of papers as deliverables, it means that the country has enough research resources to produce academic articles by themselves, with little need to rely on international coauthorship.

Number of articles and GDP per capita



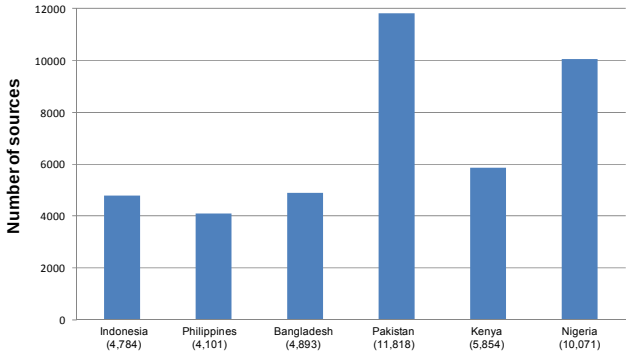

Number of articles and the international coauthorship rate



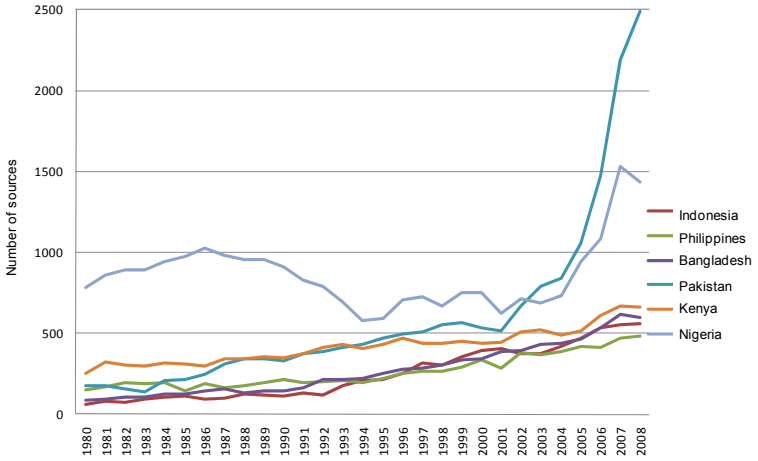

## 3.2 Academic publishing in six target countries (case study)

### (1) Movements in the number of scholarly papers and socioeconomic situation

We chose six countries among nations that published more than 5,000 scholarly papers between 1981 and 2006 as targets for the case study, considering income level (low income level) and regional balance. These consist of two each from three regions: Indonesia and Philippines from Southeast Asia, Bangladesh and Pakistan from South Asia, and Kenya and Nigeria from Sub-Saharan Africa. According to the WoS data, the number of papers published between 1998 and 2008 reached more than 10,000 in Pakistan and Nigeria, while that of the other four countries remained around half that figure (4,101 in the Philippines and 5,854 in Kenya).




The number of papers in the five countries, excluding Nigeria, increased monotonously between 1980 and 2008, although there was a little fluctuation. Pakistan is notable for its rapid increase from 2000. For Nigeria, the number of papers was three times as large as those of the other five countries in 1980, but it began to decline in 1986 and took 20 years (until 2006) to finally return to the same level as before the decline. In Nigeria, the GDP per capita and the average life expectancy declined or remained sluggish during this 20-year period. This suggests that the decline or slump in Nigeria's academic publishing can be attributed to an outflow of researchers triggered by not only aggravated people's lives but also the deteriorated research environment at universities.



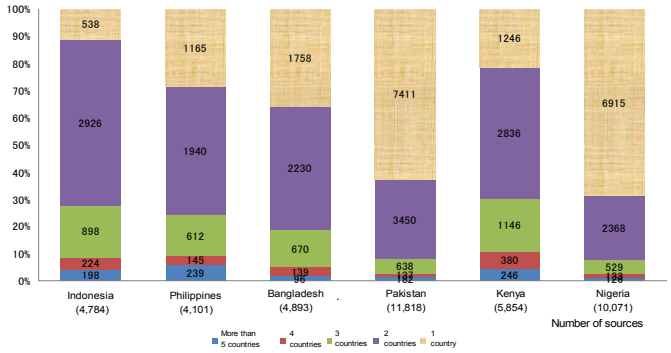

## (2) Characteristics of the international coauthorship rate and the ownership of sources

The international coauthorship rate of four countries with a relatively small number of articles is high, ranging from 70% to 90%, while it is smaller in Pakistan and Nigeria with a relatively large number of articles (30–40%).In reality, the international coauthorship rate of these six countries is higher than that of the whole world (18.8%) between 2001 and 2005. With regard to the ownership rate of articles (the percentage of articles that include the name of the given country in the reprint address among the total articles of each country), Pakistan and Nigeria, which have many articles, show almost 80% (78.4% and 79.0% respectively), while Indonesia with a small number of articles shows as low as around 30% (exactly 28.3%).

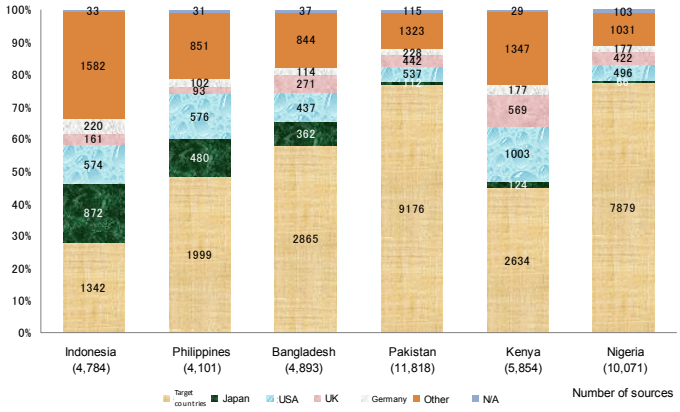
The U.S., Japan, the U.K., and Germany are commonly included in the top 10 countries, which are in the reprint address of the articles produced with six target countries. The U.S. accounts for a larger share in five out of six countries excluding Indonesia than the other major coauthor

countries, while Japan holds an important share in three countries that are geographically closer (Indonesia, the Philippines, and Bangladesh) among the six target countries. It is accordingly considered that the U.S. exerts a great influence on academic publishing in developing countries regardless of regions, while Japan tends to engage in international coauthorship with developing countries that are geographically close and is likely to hold the ownership of the articles.

Number of countries engaged in academic writing



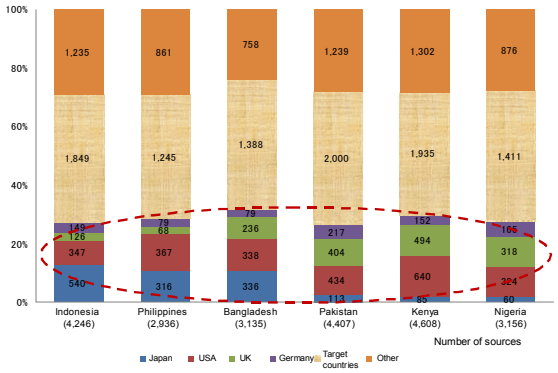

Ownership of sources (%)



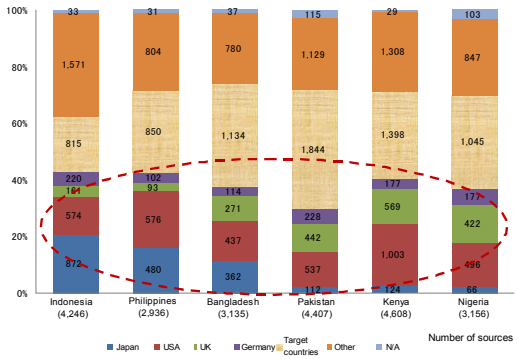

The total percentage of the ownership of four major coauthor countries (U.S., Japan, U.K., and Germany) to the six target countries is higher than their total international coauthorship rate. Therefore, these four countries could tend to play a leading role in international coauthorship. For Japan, the trend can be identified especially with two Southeast Asian countries as the country has many joint papers with them, and it is considered that Japan will often take leadership in academic writing with them.

Coauthorship of the six target countries might be influenced by financial relationships among countries. According to the following fund flow chart by country, which is based on the accumulation of funds between the six countries and the major coauthor countries for 10 years from 1998 to 2007, the U.S. assumes a dominant position in five countries excluding Nigeria. Japan has as large a share as the U.S. in Indonesia and the Philippines (35.7% in Indonesia and 37.8% in Philippines).

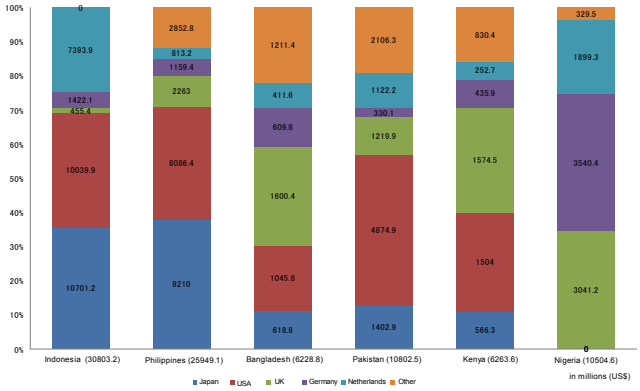
Share of major countries
in international coauthorship




Ownership rate
under international coauthorship



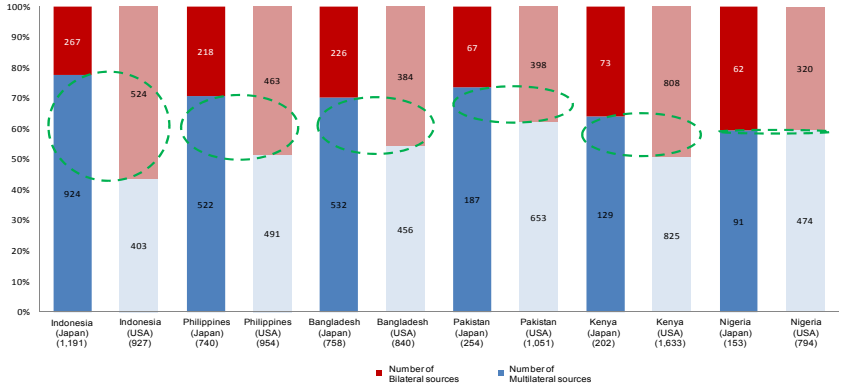

Fund flow chart between target countries and major international coauthor countries
(accumulation of 10 years)




Source: Compiled based on OECD International Development Statistics

## (3) Characteristics of international coauthorship in Japan

When we compare the characteristics of coauthorship between Japan and the target countries with those between the U.S. and the targets, it can be confirmed that a share of bilateral coauthorship is bigger than multilateral joint writing in regions geographically close to Japan such as Southeast Asia. In the meantime, the difference between Japan and the U.S. becomes narrower in regions that are far from Japan including two South Asian countries and two African countries. The U.S., compared to Japan, has more coauthors who belong to high-income OECD countries (see the main text for details).



## 4. Interview survey report

### 4.1 Domestic interview (preliminary survey) report

According to the interview focused on Japanese researchers who have a large number of joint papers with researchers in the Philippines or Indonesia, it was confirmed that the government measures, including acceptance of foreign students and international cooperation, helped exchange with these countries and that coauthorship was mainly conducted in the form of a joint paper with doctoral degree students who returned to their home countries or acknowledgements to natural resource providers. The following ideas were proposed with regard to future support: Research education for foreign students based on an assumption that they will continue research after getting a degree in Japan and returning to their home countries, and assistance to these researchers after their returning to home countries.

### 4.2 Overseas interview report (Philippines and Indonesia)

#### Support from the governments and universities to recent research activities

The Philippine government supports a project to organize research promotion measures and enhance graduate schools of Engineering. The Department of Engineering of the University of the Philippines has increased the number of faculty members and reduced their educational responsibility. Furthermore, they have increased faculty's salary, which is often reported as exceptionally low. In Indonesia, the University of Indonesia has introduced a new professor post that focuses on research (with higher salary and less teaching responsibility), and the Bandung Institute of Technology offers rewards to internationally published scholarly papers.

#### Academic career path of researchers and reasons for returning to home countries

All the target researchers have experienced research training in overseas for a degree. The main reason for returning to home countries after getting a degree was as follows: For the Philippines, family comes first; for Indonesia, an agreement with the sending organization (e.g., researchers are required to serve for a certain period [usually double the duration of overseas study + one year] after returning home) and willingness to contribute to the country were major reasons, in addition to family matters.

#### Incentives for international coauthorship

International publishing of scholarly papers is highly esteemed as accomplishments in the target universities in the Philippines and Indonesia. In the Philippines, faculty members who seek promotion to a professor post are required to continuously present papers in international journals, while in Indonesia, there are national standards for the evaluation of employment/promotion of faculty (i.e., certain points are given according to accomplishments) and international publishing of research results is provided with high points.

#### Breakdown of international coauthors and advantages of international coauthorship

Most of the coauthors are academic supervisors in recipient universities or acquaintances from overseas post doctoral period. Coauthorship is often conducted with academic supervisors immediately after researchers' return to their home countries; however, they gradually come to engage in joint writing with co-workers or domestic researchers including their students. In many cases, international coauthorship improves the quality of papers due to availability of a good experimental equipment of coauthors who belong to institutions in developed countries.

Academic supervisors have a substantial amount of international publishing as well as credibility within the academic community; thus, it is also pointed out that papers are more likely to be published in international journals under international joint writing with them.

### Treatment of faculty and the research environment

The following factors were pointed out as the constraints of research activities: Insufficient experimental equipment or fewer subscriptions of international journals; heavy educational responsibility; lack of efficient research framework due to outflow like overseas study of excellent graduate students (young faculty) and inefficiency in administrative process. In the Philippines and Indonesia, “research culture” is not strongly rooted; thus, even if researchers have a strong willingness, it is difficult for them to keep up motivation of research. Development of researchers in the next generation due to lack of faculty members with ability to provide research guidance and insufficient treatment of faculty (i.e., low salary) would be their next challenge.

### Support from Japan

The Japanese Embassies in the Philippines and Indonesia concern that the status of international students who have completed study in Japan (i.e., whether they return home or remain in Japan) is not well known and they are not well utilized after returning to their home countries. JICA has launched a project to support the Engineering department of major universities in ASEAN, which is highly appreciated among the faculty members we interviewed in both countries, for a great advantage including opportunities for university teaching staff in the region including Japan to know each other.

## 5. Summary of the results and discussion

In this survey, we attempted to have a quantitative understanding of the research outcomes of developing countries, which used to attract little attention, with focus on international coauthorship based on Thomson Reuter Scientific’s data considering scholarly papers. First of all, we found that the global trend of international joint writing amid the growth of the number of papers is that the international joint writing rate increased for 10 years from 1998, and identified regional differences in the international coauthorship rate.

Secondly, we analyzed six developing countries and found out that a country with a small number of papers shows a high international coauthorship rate, while ownership is low. For these six countries, the U.S., Japan, the U.K., and Germany are the major countries where coauthors belong. The U.S. is more likely to play a leading role in joint academic publishing with all six nations, while Japan is more likely to do so in joint publishing with two Southeast Asian countries

In order to maintain and expand international researchers’ networks, Japan, for example, should maintain the leadership role in those two countries in an advanced manner. They have a framework to motivate faculty to present their research results internationally (e.g., they highly value a paper published in international journals), although there are issues they should address, including the development of a research environment to utilize the system. In the meantime, Japan seems to have many joint papers published with these developing countries by cooperation between international students from these countries and their Japanese academic supervisors. Therefore, what Japan should to support them is to increase the number of foreign students who

study in natural science doctoral degree courses, provide training that considers their return to home countries, and support their research in their home countries.

The objective of this analysis is limited to the understanding of actual status; thus, it may be required to specify factors that have a substantial effect on the level of and change in the number of papers through a quantitative analysis, which would be our next theme related to this study. Furthermore, it might be necessary to get the picture of research activities in countries other than the two Southeast Asian nations.

# 1. Introduction

## 1.1 Background and objectives of the survey

There still exists a large income gap between advanced countries and developing countries. In the meantime, some of the developing countries such as India and China are experiencing a rapid economic growth, followed by increased national income and proliferation of higher education. Research activities in the developing countries might also be actively pursued accordingly.

We assume that many of the developing countries have introduced some kind of investment in order to promote the nations' research activities over a half-century. In the meantime, advanced countries have supported developing nations in their research activities through the acceptance of overseas student and academic exchange between researchers of each country. Therefore, both advanced and developing countries will be required to understand the outcomes of these investments in an appropriate manner.

The development of basic information concerning research activities in developing countries would help the Japanese government make decisions on future policies, including those on science and technology diplomacy. For example, the December 2009 interim report submitted by the Council for Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology proposed the strategic promotion of science and technology diplomacy in order to resolve global challenges and common regional issues. The report referred to cooperation with developing countries in Asia/Africa concerning science and technology as well as collaboration with the Asian countries based on equal partnership (development of a mutually beneficial relationship). International coauthorship is increasing worldwide, but the rate of such coauthorship remains lower in Japan than those of other key countries, including the U.S., the U.K., and Germany. Developing countries with a close relationship with Japan (mainly in the Asia) would be promising partners to enhance researchers' networks if Japan is to expand international academic partners in the future.

In the meantime, the actual status of research activities in developing countries has been little known so far. There could be several reasons behind this including the scale/priority of research activities. First, most research and development (R&D) was conducted in advanced countries, and the scale of R&D in developing countries was small enough to ignore. Secondly, developing countries are full with economic developmental issues that need to be addressed and R&D is not given high priority. Lastly, there is the index problem, which refers to limited access to information necessary for the quantitative understanding of research outcomes in developing countries.

The primary objective of this survey is the quantitative analysis of research results of developing countries with a view to the above problems. First of all, we analyzed movements in the number of scholarly papers in developing countries and the difference between these countries based on the index. The index is based on papers in the field of Natural Science, which is a form of research outcomes. We also selected several developing countries for a case study and attempted to understand the characteristics of countries that have the ownership of papers as well as the background of coauthor country selection. With regard to researchers who live in developing countries and present papers in international journals (potential coauthors with Japanese researchers), details of their activities (e.g., incentives for publishing international scholarly papers, networking for international coauthorship) have been little known so far. The second

objective is to shed light on the realities of research activities and the development of researchers in two Southeast Asian countries and clarify issues that need to be addressed so that we can more accurately understand the background of the data analysis and develop suggestions about Japan's support for developing countries.

## 1.2 Outline of the survey

This survey is organized into two major parts. The first part is based on the analysis on the data of scholarly papers for the purpose of quantitative understanding of research activities in developing countries[1]. The second part consists of case studies aimed at understanding the research status and problems in developing countries, and they are a qualitative analysis mainly based on interviews.

### (1) Outline of data analysis

Analysis on the data concerning scholarly papers consists of a worldwide analysis in order to understand the status of developing countries and a detailed analysis focusing on six countries. The former mainly uses the National Science Indicators, 1981–2006, Deluxe Version (hereinafter referred to as "NSI 2006"), while the latter mainly refers to the Web of Science (hereinafter referred to as "WoS"). The data used for the analysis are explained in the following part. Duration of the data period and target countries will be described in each chapter/part as necessary since they vary depending on the purpose of analysis or results of various database merger.

#### ① Data source

Data of scholarly papers:

We use Thomson Reuters Scientific's data (NSI 2006 or WoS). According to the user documentation, NSI 2006 considers three kinds of documents, namely, articles, notes, and reviews, as scholarly papers and classifies them into 24 fields consisting of 106 sub-categories. Furthermore, the NSI 2006 includes 180 countries and regions that published more than 100 papers in academic journals, which Thomson Reuters considers as the sources of its paper data for 26 years from 1981 to 2006. Table/Chart 1 shows the outline of the NSI 2006 data. The average number of papers published by a country was 107,777 during this period, while the average citations a country received was 8.2. The total number of papers published in the entire world was 16,777,329 and that of citations was 236,102,242 over the same period.

Table/Chart 1 Outline of NSI 2006 data

| Variance | Sample | Average | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Citations | 180 | 1,577,195 | 9,728,234 | 27 | 124,573,901 |
| Sources | 180 | 107,777 | 502,292 | 102 | 6,122,412 |
| Average citations | 180 | 8.19 | 4.4 | 0.04 | 24.12 |

Socioeconomic data: World Development Indicators 2007 (WDI 2007), the World Bank

Fund flow data between countries: International Development Statistics (IDS), OECD

[1] What kind of index should be used to present research results is an issue. For example, a database or programming may be included in research results, while there are research results that will not be disclosed to the public for corporate interest or military purposes. This survey focuses on academic publishing as a result of general research activity.

Higher education data: UNESCO Institute of Statistics (UIS) (concerning overseas students) and others

② Definition of terms

Papers of the target countries:

Academic papers of a target country is defined as those in which the name of the target country (e.g. “Indonesia”) is included in the “author’s address” (an item in NSI 2006/WoS).

Number of papers:

For internationally coauthored papers involving multiple countries, the number of papers is counted by mainly using the integral counting method (each country is counted as one). However, the fractional counting method, in which the number of papers is divided by the number of coauthor countries (if countries A and B are coauthors, each of them is counted as 1/2) is used as necessary.

Classification of fields:

This report uses Essential Science Indicators’ (ESI) 22 categories, and the eight fields in the portfolio integrating them (*Saka & Kuwahara, 2008*) (Table/Chart 2).

Table/Chart 2 Classification of fields (eight fields and 22 categories)

| Eight Fields | ESI 22 Categories |
|---|---|
| Chemistry | Chemistry |
| Environment/Ecology&Geosciences | Environment/Ecology |
| | Geosciences |
| Basic Biology | Agricultural Sciences |
| | Biology & Biochemistry |
| | Immunology |
| | Microbiology |
| | Molecular Biology & Genetics |
| | Neuroscience & Behavioral Science |
| | Pharmacology & Toxicology |
| | Plant & Animal Science |
| Computer Science&Mathematics | Computer Science |
| | Mathematics |
| Engineering | Engineering |
| Materials Science | Materials Science |
| Physics&Space Science | Physics |
| | Space Science |
| Clinical Medicine&Psychiatry/Psychology | Clinical Medicine |
| | Psychiatry/Psychology |
| Others | Economics & Business |
| | Multidisciplinary |
| | Social Sciences, general |

Quality of papers:

The average citations (average number of papers quoted per country/researcher) is used to measure the quality of papers in this survey. Although we could consider papers ranked among the top 1% or the top 10% in the average number of citations in each subject category as

high-quality papers, these may not include a sufficient number of papers produced in developing countries. It is also possible to use the h-index[2], which represents the quantity and quality of papers at the same time, but *Negishi 2008* pointed out that the index basically tends to be proportional to the number of papers and needs to be adjusted if the size of data differs greatly. This index may not be appropriate for this survey as we compare academic publishing between developing countries with a small number of papers and major advanced countries with substantial amount papers.

Higher education:

Higher education in this report is defined as education higher than ISCED 5 (defined in the International Standard Classification of Education (ISCED) 97). In Japan, it equals to education in Universities or Graduate School.

(2) Outline of qualitative analysis

Our interview survey consists of preliminary (in Japan) and international (in Philippines and Indonesia) surveys. The preliminary survey was conducted in August and September 2009, while the international survey was done in October 2009. The main targets were researchers in the target countries who had published internationally a large number of papers, which were selected based on WoS. The overseas survey also included, in addition to them, the target countries' personnel in charge of research promotion measures, education for researchers, and support from Japan. Please refer to Chapter 5 for details.

## 1.3 Composition of the report

Chapter 1 describes the purpose and outline of the survey. In Chapter 2, we review the existing documents related to the theme of this survey and then overview the status of academic publishing in the entire world in Chapter 3. Here, we analyze the relationship between academic publishing and socioeconomic index. Subsequently, we review movements in the number of papers depending on the income level and the region and the characteristics of each category, and analyze the characteristics of international coauthorship. Chapter 4 consists of case studies of selected six developing countries and analyzes them focusing on international coauthorship. Specifically, this chapter conducts analysis from the viewpoint of how much ownership of sources is held by those developing countries as well as what is the major factor in selecting coauthor countries. Furthermore, we attempt to shed light on the characteristics of Japan's coauthorship by comparing with the U.S. Chapter 5 reports the results of the interview surveys of Japanese researchers and local researchers concerning the research environment and the education for researchers in the Philippines and Indonesia. Finally, Chapter 6 summarizes the result and explains our discussion.

[2] h-index: for example, a figure which means that there are more than "h" papers with more than "h" citations among papers published by a researcher

## 2. Review of existing bibliographies

We reviewed existing bibliographies in related fields as this survey focuses on themes in multi-fields. For instance, we studied documents concerning bibliometrics, followed by documents regarding research activities in developing countries so as to use academic publishing as an index. As a result, neither quantitative understanding of research activities in developing countries nor studies focusing on the reality of research activities with regard to researchers who stay in developing countries and present their research outcomes in international journals seem to exist, as long as we know.

A general interest in bibliometrics seems to have increased for its value as an objective method of research evaluation. Please refer to the paper written by Dr. Negishi in the 1990s for discussion about utilization or points to remember concerning bibliometrics (*Negishi, 1999*). In the meantime, *Chou, 2004*, questions whether it is appropriate to use a bibliometrics index for research evaluation without cautious consideration, while it also states that utilization considering the limit of method should bring various merits. The target unit of research evaluation can be individual, institution, nation, or the like. An analysis by country was mainly conducted focusing on the characteristics of academic publishing in the U.S., Japan, the U.K., and Germany, which produce a large number of papers, as well as comparison between countries, as shown in *National Institute of Science and Technology Policy, 2005*.

With regard to academic publishing in the developing countries, *Ioannidis, 2004*, analyzed academic publishing and international movement with attention to brain drain from developing countries to advanced countries. This study targeted the researchers who received the highest average citations in 1981–1999 (1,523 researchers in total), and their movements were analyzed in 21 subject categories. As a result, it was identified that approximately 32% of the researchers no longer live in their home countries and that the percentage of foreign researchers varies depending on the advanced country that hosts these researchers. *Yamashita, Ueno, Tomizawa and Kondo, 2006*, analyzed the international movements of researchers in the field of Engineering based on the profile of the authors of papers published in three IEEE journals with a high impact factor. As a result, it was confirmed that excellent Indian researchers prefer to conduct research abroad, while Chinese researchers are likely to write papers not only in foreign research institutes but also in domestic research institutes.

*Ueno, Yamashita, Tomizawa and Kondo, 2006*, also analyzed academic publishing in China as a emerging power as well as cooperation between Japan and China. As a result, the decline of contribution by non-Chinese research institutes (a share of coauthorship with foreign institutes) was identified among the top 10% of citations in the fields of Material Science and Chemistry in which China holds a relatively large world share. In the meantime, Japan is strengthening its relative position as China's international coauthor, which means that a gap between Japan and the U.S. is narrowing in that point. There is no analysis on academic publishing concerning the other developing countries, especially those with middle income or less, as far as we know.

According to *UIS, 2009*, which compiles the status of research activities in the world, private investments in research and development (R&D) account for more than 50% of the total R&D funds in Europe and the U.S. In Asia, a private/public fund ratio of research investment differs by country; poor countries have almost no private investments, which on the other hand account for more than 80% in a country with relatively high income, such as Malaysia. In Africa, the share of private-sector investment is small in many of the countries whose data is available,

which sugegsts that the governments and higher-education agencies play a major role in R&D. With regard to knowledge development in developing countries, it is pointed out that transnational cooperations are transferring a part of their R&D to developing countries to cope with pressure from shareholders concerning cost reduction (*UN, 2005*). However, the recipients of these foreign investments are limited to countries that have a sufficient infrastructure for R&D[3]. Assuming that academic publishing in low-income countries will be conducted by public research institutes and higher education agencies rather than private institutes, we have reviewed research functions and academic publishing of higher education agencies of which documents are more available as follows:

There are several studies that analyzed higher education in developing countries (e.g., *Altbach & Umakoshi 2006, Umakoshi 2004, or Altbach & Selvaratnam 1993*) and each of them focuses on education that is the main function of universities in developing countries. The reason behind this could be that as *Nakai, 2004*, describes higher education in the Philippines, many of the higher education institutes have little room for research activities and they did not put a high priority on graduate education or research function. In the meantime, *Lim, 1999*, which is one of the few studies on research environment in developing countries lists up problems concerning the implementation of research, including a lower level of faculty's education background as well as benefits, limits of research fields, and inefficiency of the administration. *Meek Suwanwela, 2006*, is a comprehensive compilation of research environment and related measures regarding higher education in the Asia Pacific regions. Each of the studies would be effective for an overview of research environment in developing countries, mainly in Asia.

In the meantime, *Yonezawa, 2002*, focuses on case study and discusses Nigeria's higher education based on the analysis by University of Benin. University of Benin as well as the other same level federal universities have strict requirements for promotion of faculty including academic publishing in prestigious journals as of 2002 (e.g., more than 24 papers must be written within three–six years and 25% of them must appear in foreign journals for promotion from associate professor to professor). Nonetheless, the salary of the federal university faculty is extremely low and the average cost for publishing articles in international journals equals almost the monthly salary of young faculty. Such financial constraints poses a barrier for academic publishing in the country[4]. There used to be a substantial number of Western researchers visiting Nigeria and promoted academic exchange, but such activities are limited as of the report date because of the outflow of excellent personnels amid the country's social disruption over the past two decades or so.

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[3] We must consider transportation cost in economic activities. Generally speaking, case of ocean transportation rate used by developing countries is high and that of inland transportation is even much higher. *Collier, 2008*, points out that a country of which quality of life is at the lowest (bottom) level with a population of 1 billion (there are 58 such countries) tends to have problems (traps) which inland states have. These countries face a situation where neither infrastructure nor market in adjacent countries could be their favors.

[4] Publication cost of academic journals seems to vary depending on the category or quality of journal. According to the estimation of *The Wellcome Trust, 2004*, author's cost would be US$ 1,950 for high-quality scientific journals; while US$ 1,025 for middle-quality journals. For "open access," a business model would work if every submitter is charged US$ 175 for review/assessment in addition to the accepted authors.

# 3. Academic publishing in the world

This chapter describes analysis on the characteristics of academic publishing in the world. First, we analyze the relationship between the number of papers and socioeconomic level by country as well as the relation between quantity and quality of papers by country. Secondly, we analyze movements in the number of papers and the characteristics of categories, with a focus on the difference by income level or region. Lastly, we analyze the worldwide data to describe the characteristics (e.g., trends and regional differences) of international coauthorship, which will be analyzed in Chapter 4's case studies of six countries in detail.

## 3.1 Developmental process of academic publishing

### 3.1.1 Relationship between socioeconomic level and academic publishing

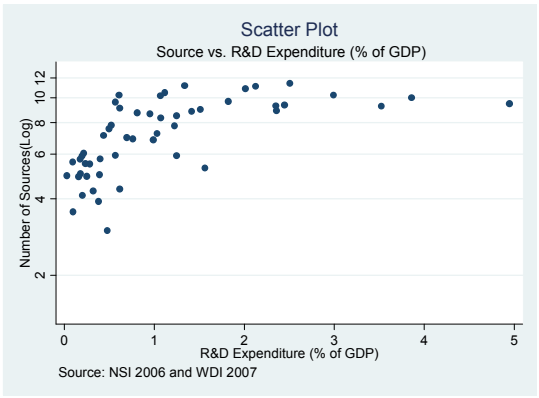
We analyze the relationship between the number of papers (sources) and socioeconomic indices by country based on NSI 2006 and WDI 2007. Table/Chart 3 (scatter plots) shows the number of sources and research activity indices (R&D expenditures and the number of researchers in R&D) that are considered to have direct effects on the number of papers. A positive correlation can be seen here between each pair of variables. The larger the amount of R&D expenditure or the number of researchers, the more enhanced are the R&D activities and the greater the number of sources as a result of them, which matches our intuition[5].

Subsequently, Table/Chart 4 (scatter plots) shows the relation between the number of sources and socioeconomic indices (GDP per capita, average life expectancy, population between ages 15 and 64, and the gross enrollment rate for tertiary education)[6]. A possibility of positive correlation can be seen here between the number of sources and GDP per capita or the gross enrollment rate for tertiary education. The higher the socioeconomic index, the larger should the R&D expenditures or the population of researchers be, which easily leads to a prediction that the number of sources and these variables have a positive correlation. In the meantime, the relation between the number of sources and average life expectancy or the population between ages 15 and 64 (i.e., active labor population) is rather vague. Since there is a low-income country with a large population, like Bangladesh, it is not so simple to explain that the number of active population is directly linked to the number of sources. Nonetheless, even a low-income country with a large population makes some research investments due to uneven distribution of gross income, and basically, a certain number of papers is likely to be published.

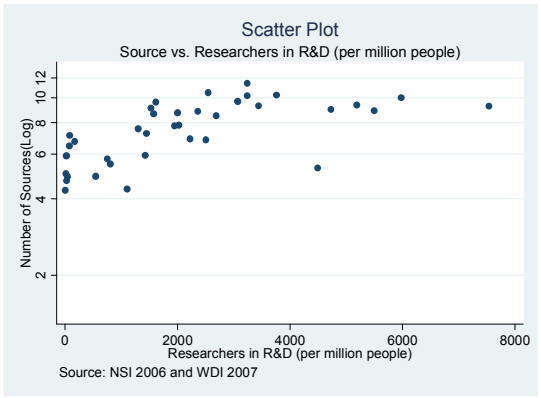
[5] Definition of researchers is based on the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics and includes students in doctoral program (ISCED97 level 6).

[6] The gross enrollment rate includes the actual number of enrolled students regardless of school age; for example, the gross enrollment rate for higher education would be over 100% if there are many adult students who take higher education.

Table/Chart 3　Relationship between the number of sources and research indices (2005)

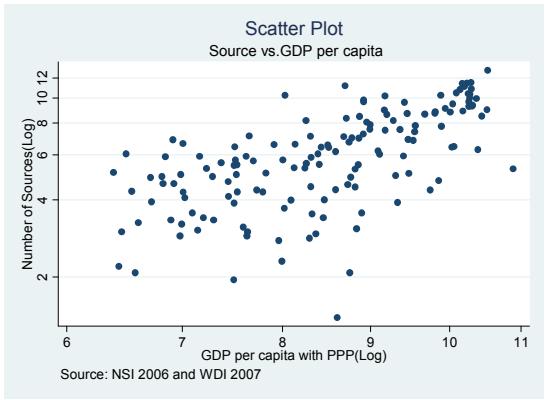



(a)　Sources and R&D expenditure (% of GDP)

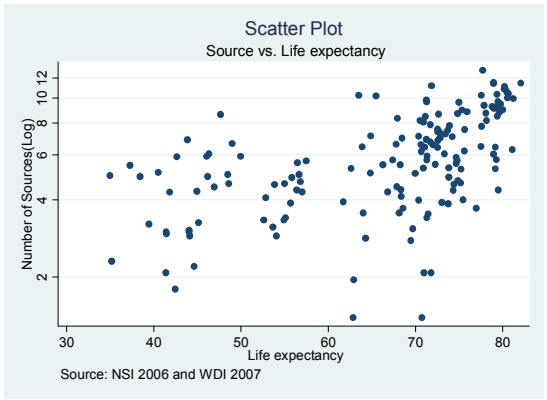



(b)　Sources and researchers in R&D (per million people)

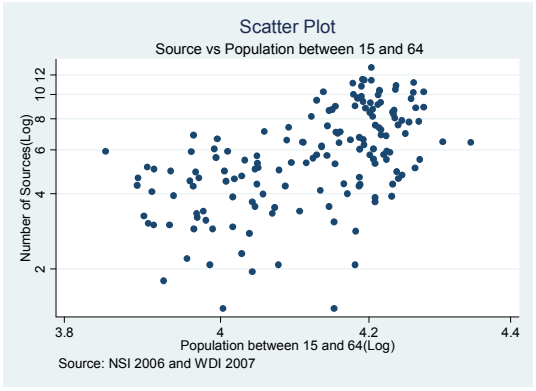
Table/Chart 4　Relationship between the number of sources and socioeconomic indices (2005)



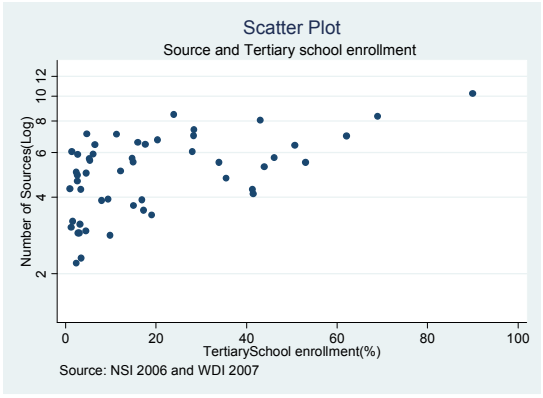

(a)　Sources and GDP per capita




(b)　Sources and life expectancy




(c)　Sources and population between ages 15 and 64




(d)　Sources and gross enrollment rate for tertiary education

### 3.1.2 Relationship between the quantity and quality of sources

The possibility of a positive correlation between the income level and the number of sources is a result easily expected from the fact that the income level has effects on the number of researchers and R&D investment (refer to 3.1.1). Similarly, high-income countries can deliver a substantial number of high quality papers probably because they have a large number of researchers who compete or collaborate with each other. Thus, the quantity and quality of papers are estimated to be affected by income level. In this section, we attempt to analyze the quality of sources per country.

(1) Relationship between the quality and quantity of sources

Table/Chart 5 shows the top 15 countries in the number of citations based on the NSI 2006 data. Bermuda comes first (24.12), followed by Guinea-Bissau (21.58), Switzerland (20.38), and the U.S. (20.35). The number of sources and citations in Table/Chart 5 greatly differs by country. The U.S. has approximately 6,120,000 sources and that of the U.K. is approximately 1,500,000, while the number of papers in Bermuda, Guinea-Bissau, Haiti, and Rwanda is less than 500.

It is easily understood that research is active in Switzerland and the U.S. and both countries produce high quality sources for their high income level as well as proliferation of higher education. On the other hand, Bermuda for example is an island country in the North Atlantic (see Table/Chart 5) with as small as approximately 66,000 populations in 2007 and known for tax haven. Guinea-Bissau, placed second, is located in the West Africa and has population that of approximately 90% of about 1.6 million people in 2005 are the absolute poor. With those into consideration, we assume that high average citations of Guinea-Bissau and Bermuda will not because they publish a high-quality paper based on the same mechanism as Switzerland or the U.S. but lie in other reasons.

We analyze the sources of Bermuda and Guinea-Bissau which are placed first and second in average citations respectively, based on the WoS data. The Bermuda Biological Station for Research publishes the most sources (142 sources) in Bermuda. The institute was established by oceanographers of the Harvard University and others for the purpose of oceanic research in 1903 (U.K. joined later). The Bermuda Biological Station for Research INC is placed in the second position (122 sources), which seems to be the same institute as the Bermuda Biological Station for Research (No.1 institute). In Guinea-Bissau, the Statens Serum Institut delivers the largest number of sources (133 sources). This is an organization of the Danish government (Ministry of Interior and Health) established for the purpose of preventing infectious disease. The Projecto de Saúde de Bandim, a joint health project by Guinea-Bissau's Ministry of Health and the Statens Serum Institut of Denmark comes second (66 papers)[7].

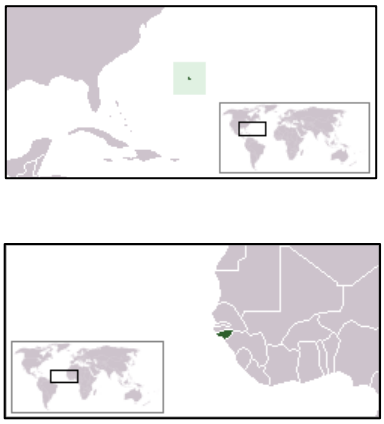
According to the above description concerning academic publishing, we can see how strongly academic publishing in Bermuda and Guinea-Bissau are affected by foreign countries. Therefore, we consider that the high average citations of these two countries are affected by factors other than their own research resources, besides the scarcity of studies targetting these countries. This trend may be applied to the other developing countries, which publish a small number of sources with a high average number of citations. The quality of papers of a country seems to not

[7] With regard to sources of Bermuda, we were able to track the reprint addresses of 417 papers; among them 183 papers had addresses in Bermuda. For Guinea-Bissau, the reprint addresses of 260 papers could be tracked; among them 46 papers had addresses in the country.

necessarily reflect the level of intellectual production in the country. Thus, the quality of sources, especially those produced in the developing countries, should be discussed with quantity taken into consideration.

Table/Chart 5 Top 15 countries in average citations (Left: List of countries, Right: Locations of Bermuda and Guinea-Bissau)

| Ranking | Country | Sources | Citations | Average citations per source |
|---|---|---|---|---|
| 1 | BERMUDA | 396 | 9,553 | 24.12 |
| 2 | GUINEA BISSAU | 221 | 4,770 | 21.58 |
| 3 | SWITZERLAND | 277,799 | 5,662,540 | 20.38 |
| 4 | USA | 6,122,412 | 124,573,901 | 20.35 |
| 5 | PANAMA | 2,200 | 44,071 | 20.03 |
| 6 | SWEDEN | 310,901 | 5,729,121 | 18.43 |
| 7 | DENMARK | 157,607 | 2,841,231 | 18.03 |
| 8 | SENEGAMBIA* | 1,653 | 29,592 | 17.9 |
| 9 | NETHERLANDS | 389,929 | 6,855,899 | 17.58 |
| 10 | ICELAND | 5,708 | 100,146 | 17.54 |
| 11 | HAITI | 256 | 4,471 | 17.46 |
| 12 | RWANDA | 394 | 6,742 | 17.11 |
| 13 | UK | 1,497,869 | 24,992,023 | 16.69 |
| 14 | GAMBIA | 862 | 14,103 | 16.36 |
| 15 | LIBERIA | 193 | 3,124 | 16.19 |



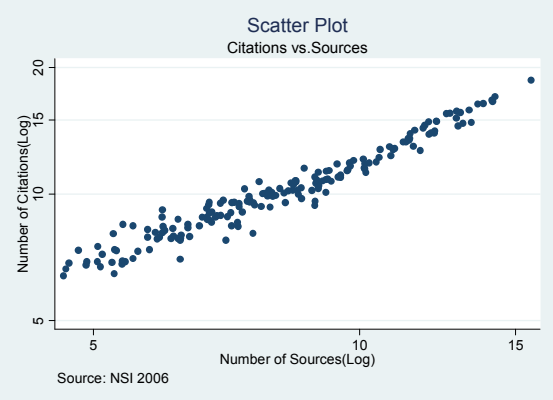
Above: Bermuda, Below: Guinea-Bissau

Source: Wikipedia, the free encyclopedia

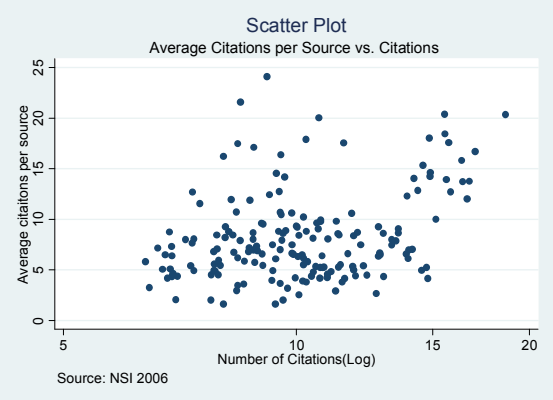
Note: *The Senegambia Confederation used to exist in West Africa, but it resolved due to deterioration of the relationship between Senegal and Gambia in 1989.

For more detail on the relations between the quality and quantity of sources, Table/Chart 6 (scatter plots) shows correlations between two variables among indices (number of sources/citations, average citations) concerning academic publishing in 2006. First, Table/Chart 6 (a) shows that there is a positive correlation between the number of citations and sources, which means a simple relation that the more the number of sources, the higher is the number of citations. Secondly, (b) indicates a vaguer correlation between the average citations per source and the number of citations. For a country with a large number of citations, the more the number of citations (quantity), the higher is the average citations per source (quality). However, even among countries with small citations, some have high average citations per source, which indicates a possibility that the correlation between variables differs depending on the number of citations. The correlation between the number of sources and the average citations per source shown in (c) is similar to that of (b): high-income OECD countries with a great number of high quality sources are located in the upper right corner of the plot area, while islands with small populations including Bahamas and Seychelles as well as African countries such as Gabon and Rwanda with a small number and high quality sources are placed in the upper left. The correlation between quality of sources and income shown in “Reference” is similar to (b) or (c) to some extent, yet it is more ambiguous.

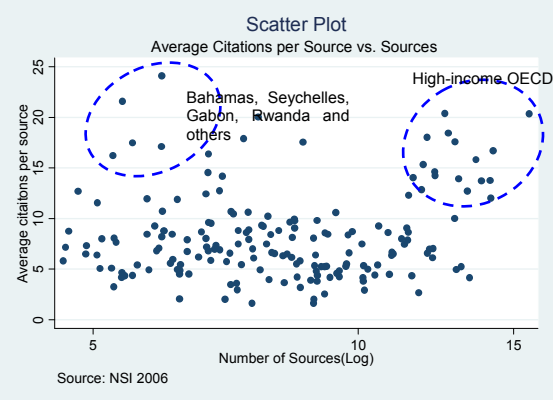
Table/Chart 6　Relationship between academic publishing indices



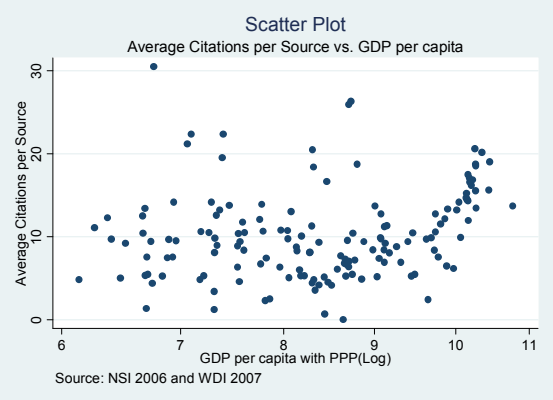

(a)　Citations and sources




(b)　Average citations per source and citations




(c)　Average citations per source and sources




(Reference)　Average citations per source and GDP per capita (2000)

(2)　Relationship between the quality and the subject category of sources

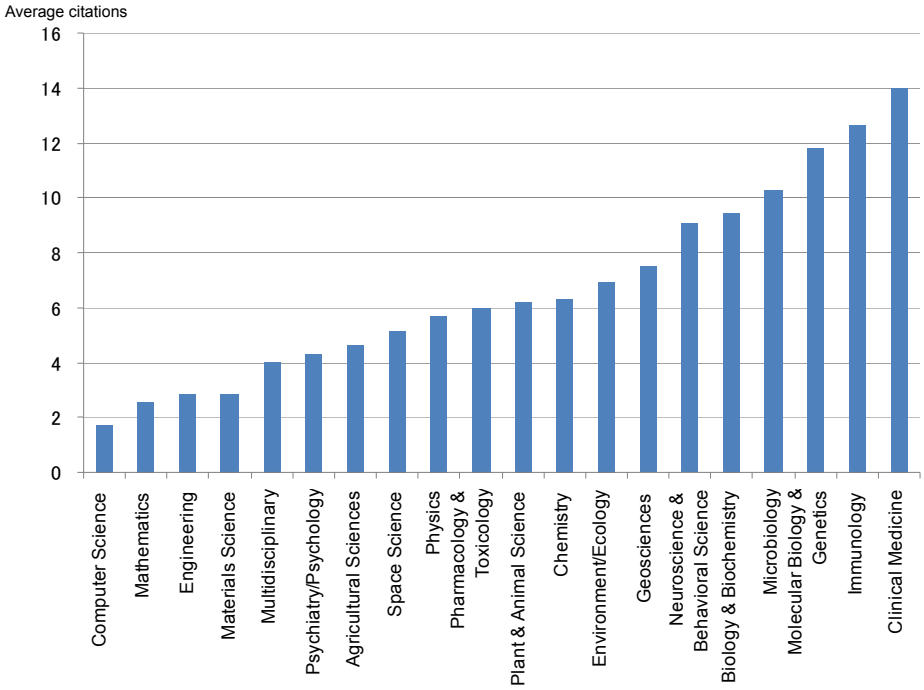
For a comparative analysis on the quality of sources of each country, the structure of the subject categories of sources needs to be considered. It is obvious that the number of sources varies depending on the category as each one has its own manner of producing articles. From this perspective, we analyze data to identify differences between subject categories[8].

Table/Chart 7 shows the average citations by category at five-year intervals between 1985 and 2005 based on the data concerning 161 countries. The highest average number of citations per source is around 14.0 in Clinical Medicine, while the lowest is Computer Science (around 1.7), which means that there is a roughly eight-fold difference between them. If we assort these categories into smaller units, average of citations of each unit would show a different trend even

[8] For example, the Board of Directors of the Mathematical Society of Japan stresses in its proposal concerning the evaluation of research outcomes that the field of mathematics is rather special compared with the other fields for longer yet small number of sources. The Board also states that the number of citations tends to be smaller in mathematics because this field has a smaller number of researchers than the other fields such as Physics and more dispersed research themes. For this reason, the proposal concludes that it is pointless to simply compare mathematics with other fields by the number of citations. http://mathsoc.jp/proclaim/gyousekihyouka.pdf

within the categories used in this study. However, the above results clearly show that the average number of citations varies by field in general. This suggests that one should pay attention to category structure and its trend of citations when comparing the quality of sources by country.

Table/Chart 7 Average citations by category




## 3.2 Characteristics of academic publishing by income level/region

According to *Saka & Kuwahara, 2008*, which analyzed the WoS data of Thomson Reuter Scientific (1981–2007), the number of sources in the entire world was 955,706 in 2007, which is around two times larger than that of the early 1980s. Therefore, it is assumed that research activities tend to increase consistently. The replacement and increase of international journals included in the database is pointed out as a reason behind this. The WoS database in January 2010 consists of 16,346 journals[9]. This section analyzes the characteristics of academic publishing by income level or region in the context of a international increase in research activities and the number of articles published.

[9] Please go to the following website for the number of international journals and their contents:
http://www.thomsonscientific.com/cgi-bin/jrnlst/jlresults.cgi?PC=MASTER
Their criteria for inclusion are publishing rules, contents, internationality, citations, and others.
http://www.thomsonscientific.jp/resources/selection/criteria.shtml

Column 1: Backgrounds of increase in the number of sources and their forms of presentation

Behind the increase in the number of sources, there seem to be the expansion of supply and demand for research activities and opportunities to report outcomes. First, the number of researchers and R&D investment increases when knowledge creation and technological development are generally acknowledged or expected as a source of economic growth. The development of study itself (deepening, specialization, and integration of the fields of study) is considered to be related to the increase as well. Secondly, researchers have motivation to publish as many papers as possible if their achievement is evaluated based on research results, including the number of papers, although it is highly possible that the situation may differ by field. When these evaluations (often expressed with the phrase "Publish or perish" of "Publish, not perish" in the U.S.) become common and the number of researchers is sufficient, demand for opportunities to present research results will be increased.

The increased number of scholarly papers can be connected with the increase in the number of academic journals to meet such needs. According to *Toshimori, 2005*, the number of foreign journals possessed in Japan was 18,175 in 1980, which increased about 1.5 times in 2002. Academic journals are mainly published by academic societies or commercial publishers. The latter increases journal price (including package price) whenever a new journal is published with a view to increasing profit. A price hike of overseas journals is actually controversial in Japan as well. The Japan Association of National University Libraries states that the price hike is attributable to inactive price competition (e.g., impossibility to replace sources) or enhanced pricing power due to oligopoly among major publishers. This situation could be interpreted that the means of academic communication is in the hands of commercial publishers, although both producers and consumers are academic researchers (http://iulwww.lib.iwate-u.ac.jp/EJQandA.pdf).

The number of papers is likely to rise in the future as long as supply and demand for opportunities to present paper increases as research activities are enhanced. A form of presentation (publishing) may diversify depending on the institution's repository (electronic archives of research institutes) and the increase in the number of academic journals (or those publishers) with open access policy. We should keep an eye on what kind of impact the diversification of a form of publishing and the increased number of sources will have on the future research activities in general and how their impacts on individual researchers will vary.

### 3.2.1 Data outline

By combining the data of NSI 2006 and WDI 2007, we created data for the analysis, which covers a period of 20 years between 1985 and 2005 (five time-points at five-year intervals) and includes 161 countries.

Table/Chart 8 shows the classification of regions and countries constituting them, based on WDI 2007. The Europe and Central Asia region is the largest, consisting of 47 countries, followed by Sub-Saharan Africa with 42 countries. Table/Chart 9 indicates the income level classification and countries constituting each income category, based on WDI 2007. The low-income category consists of 52 countries, which is the largest among the classification and the number of countries declines as the income level goes up. Table/Chart 10 explains the characteristics of academic publishing by income level. India and China are examined separately because they have larger populations than the other members of their income categories and their economic growth is outstanding. The number of sources greatly differs among the three income categories: low, middle, and high. The average number of papers in India and China is similar to that of

high-income countries rather than that of the rest of the countries grouped in the same income categories they belong to.

Table/Chart 8 Regional classification based on WDI

| Region | East Asia & Pacific | Europe & Central Asia | | Latin America & Caribbean | Middle East & North Africa | North America | South Asia | Sub-Saharan Africa | |
|---|---|---|---|---|---|---|---|---|---|
| Number of countries (Total 161) | 22 | 47 | | 26 | 17 | 2 | 5 | 42 | |
| Member countries | Australia | Albania | Moldova | Argentina | Algeria | Canada | Bangladesh | Angola | Niger |
| | Brunei Darussalam | Armenia | Netherlands | Bahamas | Bahrain | United States | India | Benin | Nigeria |
| | Cambodia | Austria | Norway | Belize | Egypt, Arab Rep. | | Nepal | Botswana | Rwanda |
| | China | Azerbaijan | Poland | Bolivia | Iran, Islamic Rep. | | Pakistan | Burkina Faso | Senegal |
| | Fiji | Belarus | Portugal | Brazil | Israel | | Sri Lanka | Burundi | Seychelles |
| | French Polynesia | Belgium | Romania | Chile | Jordan | | | Cameroon | Sierra Leone |
| | Indonesia | Bosnia and Herzegovina | Russian Federation | Colombia | Kuwait | | | Central African Republic | South Africa |
| | Japan | Bulgaria | Serbia and Montenegro | Costa Rica | Lebanon | | | Chad | Sudan |
| | Korea, Rep. | Croatia | Slovak Republic | Dominica | Libya | | | Congo, Dem. Rep. | Swaziland |
| | Lao PDR | Cyprus | Slovenia | Dominican Republic | Malta | | | Congo, Rep. | Tanzania |
| | Malaysia | Czech Republic | Spain | Ecuador | Morocco | | | Cote d'Ivoire | Togo |
| | Mongolia | Denmark | Sweden | El Salvador | Oman | | | Eritrea | Uganda |
| | New Caledonia | Estonia | Switzerland | Guatemala | Saudi Arabia | | | Ethiopia | Zambia |
| | New Zealand | Finland | Tajikistan | Guyana | Syrian Arab Republic | | | Gabon | Zimbabwe |
| | Papua New Guinea | France | Turkey | Haiti | Tunisia | | | Gambia | |
| | Philippines | Georgia | Turkmenistan | Honduras | United Arab Emirates | | | Ghana | |
| | Samoa | Germany | Ukraine | Jamaica | Yemen, Rep. | | | Guinea | |
| | Singapore | Greece | United Kingdom | Mexico | | | | Guinea-Bissau | |
| | Solomon Islands | Hungary | Uzbekistan | Nicaragua | | | | Kenya | |
| | Thailand | Iceland | | Panama | | | | Lesotho | |
| | Vanuatu | Ireland | | Paraguay | | | | Liberia | |
| | Vietnam | Italy | | Peru | | | | Madagascar | |
| | | Kazakhstan | | Suriname | | | | Malawi | |
| | | Kyrgyz Republic | | Trinidad and Tobago | | | | Mali | |
| | | Latvia | | Uruguay | | | | Mauritania | |
| | | Lithuania | | Venezuela, RB | | | | Mauritius | |
| | | Luxembourg | | | | | | Mozambique | |
| | | Macedonia, FYR | | | | | | Namibia | |

Table/Chart 9 Income level classification based on WDI

| Income level | Low income | | Lower middle income | | Higher middle income | High-income OECD | High-income non-OECD |
|---|---|---|---|---|---|---|---|
| Criteria: 2005 GNI per capita | $875 or less | | $876 or more and $3,465 or less | | $3,466 or more $10,725 or less | $10,726 or more OECD | $10,726 or more Non-OECD |
| Total number of countries 161 | 52 | | 46 | | 27 | 24 | 12 |
| Member countries | Angola | Malawi | Albania | Morocco | Argentina | Australia | Bahamas |
| | Bangladesh | Mali | Algeria | Namibia | Belize | Austria | Bahrain |
| | Benin | Mauritania | Armenia | Paraguay | Botswana | Belgium | Brunei Darussalam |
| | Burkina Faso | Moldova | Azerbaijan | Peru | Chile | Canada | Cyprus |
| | Burundi | Mongolia | Belarus | Philippines | Costa Rica | Denmark | French Polynesia |
| | Cambodia | Mozambique | Bolivia | Romania | Croatia | Finland | Israel |
| | Cameroon | Nepal | Bosnia & Herzegovina | Russian Federation | Czech Republic | France | Kuwait |
| | Central African Rep | Nicaragua | Brazil | Samoa | Dominica | Germany | Malta |
| | Chad | Niger | Bulgaria | Serbia & Montenegro | Estonia | Greece | New Caledonia |
| | Congo, Dem. Rep. | Nigeria | China | South Africa | Gabon | Iceland | Singapore |
| | Congo, Rep. | Pakistan | Colombia | Sri Lanka | Hungary | Ireland | Slovenia |
| | Cote d'Ivoire | Papua New Guinea | Dominican Republic | Suriname | Latvia | Italy | United Arab Emirates |
| | Eritrea | Rwanda | Ecuador | Swaziland | Lebanon | Japan | |
| | Ethiopia | Senegal | Egypt, Arab Rep. | Syrian Arab Republic | Libya | Korea, Rep. | |
| | Gambia | Sierra Leone | El Salvador | Thailand | Lithuania | Luxembourg | |
| | Ghana | Solomon Islands | Fiji | Tunisia | Malaysia | Netherlands | |
| | Guinea | Sudan | Georgia | Turkey | Mauritius | New Zealand | |
| | Guinea-Bissau | Tajikistan | Guatemala | Turkmenistan | Mexico | Norway | |
| | Haiti | Tanzania | Guyana | Ukraine | Oman | Portugal | |
| | India | Togo | Honduras | Vanuatu | Panama | Spain | |
| | Kenya | Uganda | Indonesia | | Poland | Sweden | |
| | Kyrgyz Republic | Uzbekistan | Iran, Islamic Rep. | | Saudi Arabia | Switzerland | |
| | Lao PDR | Vietnam | Jamaica | | Seychelles | United Kingdom | |
| | Lesotho | Yemen, Rep. | Jordan | | Slovak Republic | United States | |
| | Liberia | Zambia | Kazakhstan | | Trinidad and Tobago | | |
| | Madagascar | Zimbabwe | Macedonia, FYR | | Uruguay | | |
| | | | | | Venezuela, RB | | |

Table/Chart 10　Characteristics of academic publishing (by income level)

| Income level | Low income | | Middle income | | | High income | |
|---|---|---|---|---|---|---|---|
| Breakdown | Other than India | India | Lower middle income | | Higher middle income | OECD | Non-OECD |
| | | | Other than China | China | | | |
| Number of countries | 51 | 1 | 45 | 1 | 27 | 24 | 12 |
| GDP per capita (US$)<br>* PPP adjusted | 1,332 | 2,364 | 4,592 | 3,939 | 9,390 | 26,918 | 19,317 |
| Populations (thousands) | 21,000 | 1,016,000 | 28,700 | 1,263,000 | 11,900 | 37,500 | 1,714 |
| Sources | 138 | 18,065 | 1,632 | 30,079 | 1,579 | 37,243 | 1,588 |
| Citations | 1,257 | 121,251 | 10,818 | 245,267 | 14,425 | 612,119 | 19,416 |
| Average citations | 9.84 | 6.71 | 8.07 | 8.15 | 10.01 | 15.36 | 8.88 |
| Average years of education | 3.61 | 4.36 | 7.06 | 5.64 | 8.2 | 10.96 | 8.86 |
| （Number of countries） | (22) | (1) | (26) | (1) | (11) | (22) | (2) |
| Higher-education tertiary enrollment (%) | 6.77 | 10.23 | 23.48 | 7.6 | 31.81 | 55.8 | 29.67 |
| （Number of countries） | (31) | (1) | (28) | (1) | (23) | (23) | (12) |

### 3.2.2　Movements in the number of sources and share

This section analyzes movements in the number of sources and their shares by region and by income level. India and China are analyzed independently of the income level classification for their special characteristics (the number of papers is much larger than the other countries in the same groups they belong to), as mentioned before.

#### (1)　Movements in the number of sources and share by region

Table/Chart 11 indicates a regional trend of the number of sources between 1985 and 2005. The number of papers increased in all regions and countries (India and China) during the period, yet the rate of growth was different among regions. In 1985, the number of sources in North America was slightly larger than that of Europe and Central Asia, but the situation reversed around 1990 and the gap gradually expanded until 2000. The South-East Asia & Pacific region excluding China was placed in third position following Europe & Central Asia and North America in the number of sources during this period. The number of sources in China, which belongs to this group, has jumped since 2000.

Table/Chart 12 shows the movements of the share in the number of sources. In 1985, North America and Europe & Central Asia accounted for a little more than 40% (43.3% and 40.2% respectively). However, the share of North America gradually declined (to reach 31.0% in 2005), while that of Europe & Central Asia increased (to 42.7% in 2005). The share of the East Asia & Pacific region and that of China both increased monotonously (from 9.5% and 0.7% in 1985 to 12.8% and 5.2% in 2005, respectively).

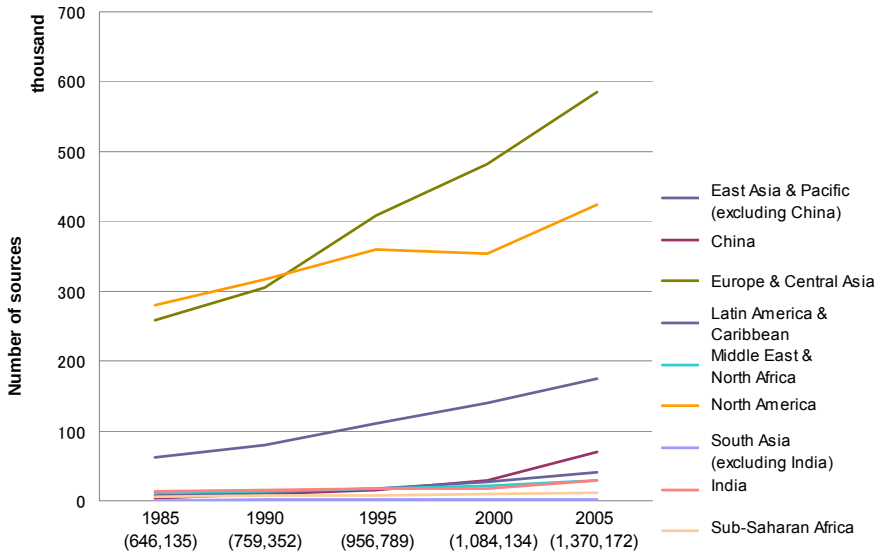
In the meantime, Sub-Saharan Africa's share of sources declined. The number of sources in Sub-Saharan Africa, to which many developing countries belong, rose approximately 1.8 times (from 6,537 to 11,801) over these 20 years. However, since the amount of increase in this region was smaller than that of the other regions, its share dropped from 1.0% to 0.9% (0.9 times the initial share). In Latin America, the number of papers increased 5.1 times (from 8,170 to 41,327) and the share also increased 2.4 times (from 1.3% to 3.0%). This situation shows that Sub-Saharan Africa, of which the number of sources was originally small, has receded further in the midst of the worldwide increase in the number of sources.

## (2) Movements in the number of sources and share by income level

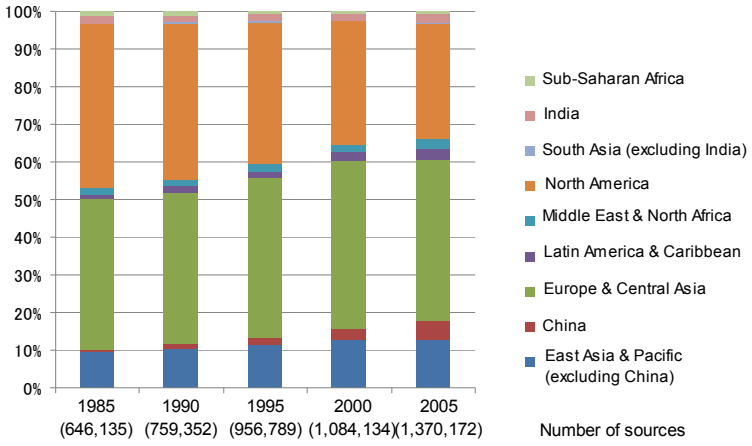
Table/Chart 13 shows movements in the number of sources by income level. The table/chart indicates that the number of sources increased monotonously in all income categories but not in the same way. China indicated a remarkable increase, while low-income nations excluding India experienced rather slow growth compared with the other regions. High-income OECD countries have more than 10 times as many sources as the other regions and their pattern of increase is almost the same as that of higher-middle-income countries. China showed the biggest increase (16.6 times), followed by higher-middle-income nations (3.84 times) in the same period. Low-income nations excluding India have the smallest number of sources with the lowest growth rate, which indicates that there is a growing gap concerning the number of sources between this income category and the other income level countries.

Table/Chart 14 shows movements in the share of sources by income level. The table/chart indicates that the trend is not uniform: Traditional oligopoly by high-income nations weakened to some extent, and China and other nations with the next highest income levels have grown to fill the gap, while the share of low-income nations decreased. The share of high-income OECD nations dropped (from 85.1% in 1985 to 78.6% in 2005), while China and other higher-middle-income nations gained share. The share of low-income countries excluding India slightly dropped from 0.8% to 0.7% over the 20 years between 1985 and 2005.

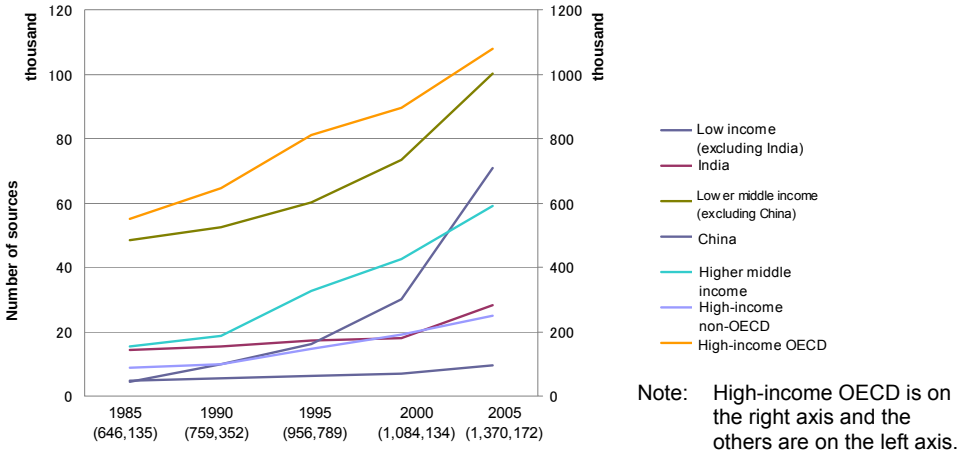
Table/Chart 11 Movements in the number of sources (by region)



Table/Chart 12　Movements in the share of sources (by region)

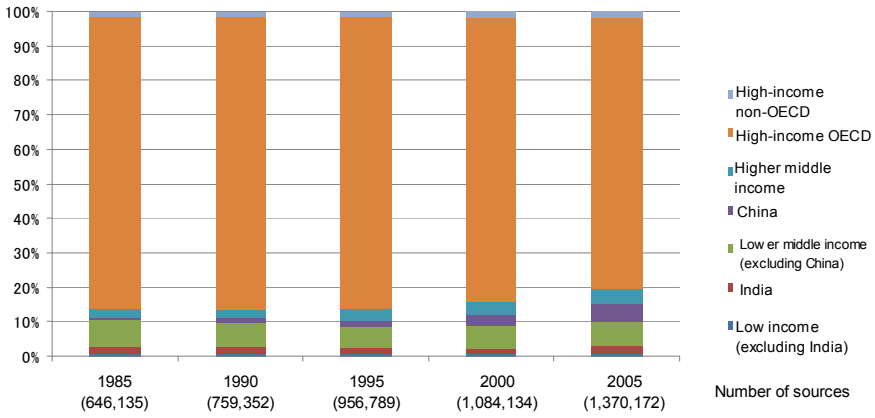



Table/Chart 13　Movements in the number of sources (by income level)




Note:　High-income OECD is on the right axis and the others are on the left axis.

Table/Chart 14　Movements in the share of sources (by income level)



Column 2: Meaning of academic publishing in developing countries

Usefulness is one of the advantages to use data for analyzing the number of papers published in international academic journals for the quantitative understanding of the production of sources in developing countries. Statistical data of developing countries is known for its high deficiency or low credibility in general. In the meantime, the data we use in this survey is concerning intellectual production in the "developing countries," of which data is "accumulated in advanced countries." Therefore, we could call it as the data with excellent usability organized in chronological order and in a cross-sectoral manner.

Analysis on academic publishing in developing countries can be conducted to some extent based on the combination of these well-organized data and other socioeconomic indices. By the way, not to mention performing such analysis, what does it mean to people in the developing countries to publish papers in international journals?

The "developing countries" are not all the same since there is a huge income gap, as well as climatic and cultural differences, not only between countries but even within a single country. The poorest nations are the same for the fact that many of the people belong to the bottom of the pyramid with insufficient basic infrastructure and unmet basic human needs. Even under these circumstances, utilization of the results from applied research concerning regional medical care or environmental issues would lead to solve the regional issues and directly contribute to the improvement of the living standards. Nonetheless, with regard to investment in basic research or even investment in applied research that takes time for the results bear fruit, it is not easy to explain cost efficiency concerning short-term life improvement compared with other urgent investment.

International competition/cooperation in R&D is in progress, including government-supported investments in R&D with large industrial and commercial potential and implementation of a large-scale international joint research, and at the same time, researchers are moving internationally for a better research environment. It is not easy to determine what the most suitable investment in academic activities is for developing countries under these circumstances. These situations may also be a reason for the drop in the low-income countries' relative share of sources.

### 3.2.3 Characteristics of subject categories by income level/region

If research activities are linked to the income level, the industry, and the culture of the country or region in which the research is conducted, the structure of the subject categories of papers may have different characteristics depending on income level or the region. Table/Chart 15 shows a breakdown of the subject categories of papers by income level. Although varied in rank, three fields—Clinical Medicine, Physics, and Chemistry—account for a large share in all income levels as well as in India and China. In the low-income countries excluding India, the share of Agricultural Sciences and that of Plant & Animal Science are a little larger than those of the other countries (the share of low-income countries excluding India and the world average are as follows, respectively: 7.2% and 1.9% in Agricultural Sciences, 14.1% and 5.9% in Plant & Animal Science) .

Table/Chart 16 indicates the breakdown of papers by field for each region. India and China are included in their respective regions here, considering the possibility that regional characteristics and category-specific trends may show similarities. The category structure of China and India is characterized as follows: the shares of Chemistry and Physics are large, while that of Clinical Medicine is rather small, compared with the structure of their regions excluding them (i.e., East Asia & Pacific except China and South Asia except India).

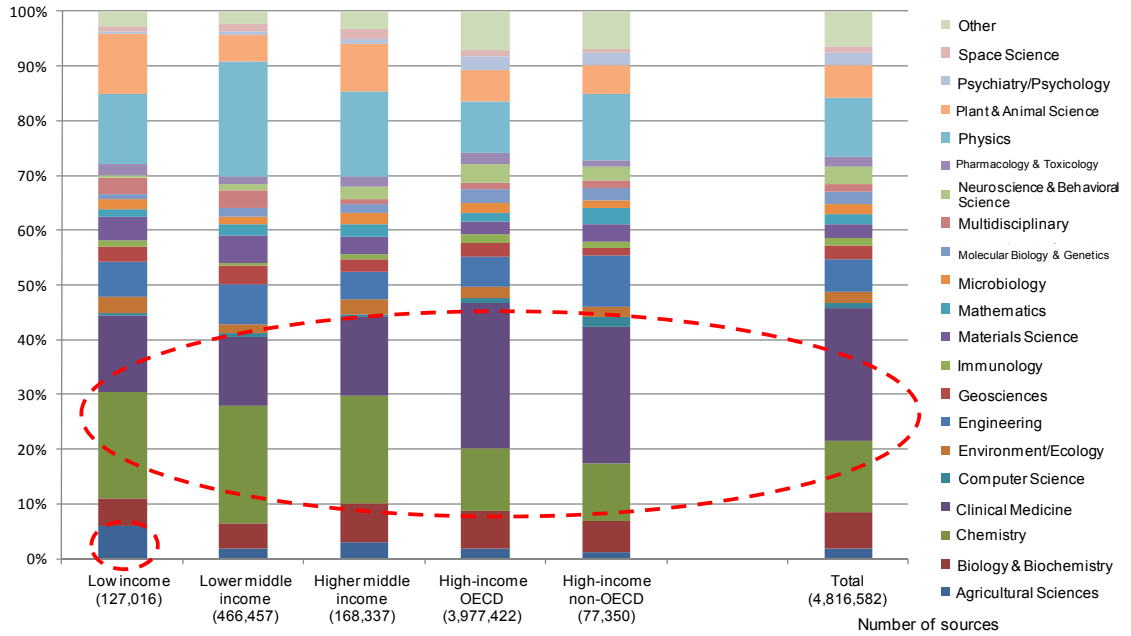
What is notable about the structure in Sub-Saharan Africa and South Asia is that Sub-Saharan Africa shows a high percentage of Agricultural Sciences and Plant & Animal Science, while the percentage of Chemistry and Physics is low compared with the world total structure (the percentages of Sub-Saharan Africa and World total are as follows, respectively: 5.5% and 1.9% in Agricultural Sciences, 16.9% and 5.9% in Plant & Animal Science, 6.0% and 12.9% in Chemistry, 3.0% and 10.9% in Physics). In South Asia, Chemistry shows a high percentage, while Clinical Medicine indicates a low rate (the percentages of South Asia and world total are as follows, respectively: 22.4% and 12.9% in Chemistry, 9.9% and 24.4% in Clinical Medicine).

Table/Chart 17 shows movement in sources by subject category focusing on certain regions. With regard to the entire world, the five-year average rate of change per category was positive for all categories, and the change rate was the largest for Computer Science (43.3%), Environment (32.5%), and Space Science (30.5%), in descending order. The share of these three categories in 2005 is as small as about 1–2%. On the other hand, Pharmacology and Multidisciplinary show a small average rate of change (11.0% and 12.1%, respectively) and the shares of these categories are also small, ranging from approximately 1% to 2%.

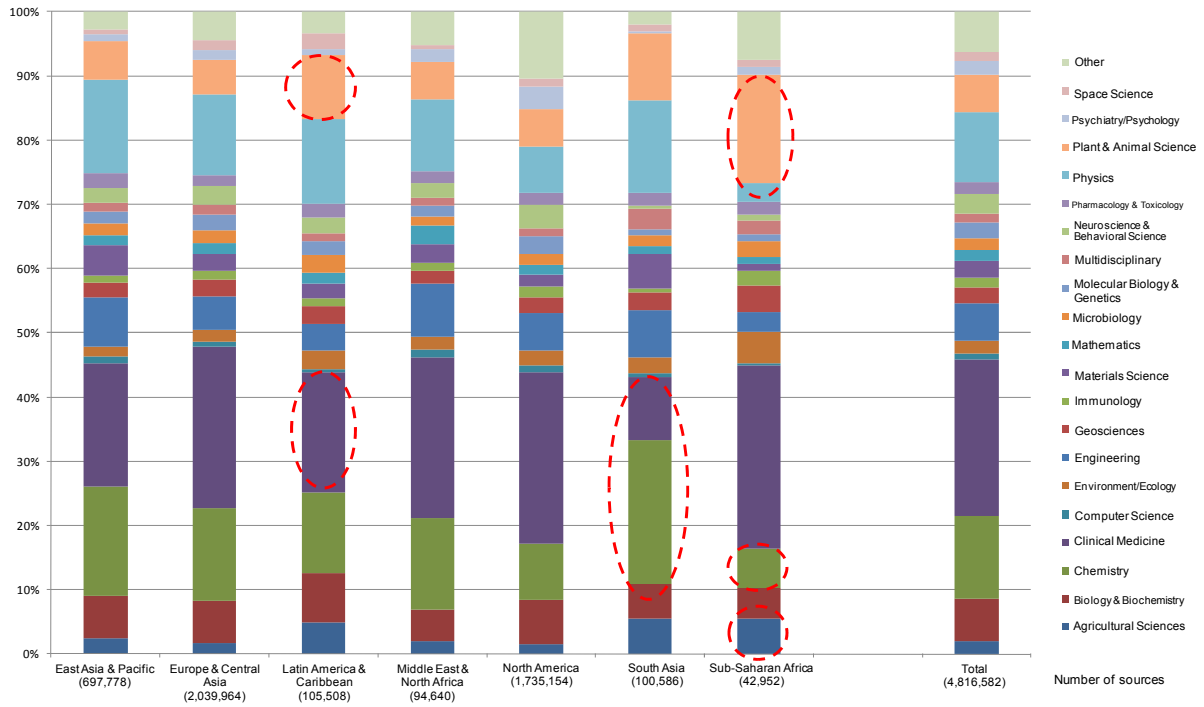
In the East Asia & Pacific region, Computer Science, Materials Science, and Physics show the highest average rates (102.1%, 58.0%, and 55.5% each), while Agricultural Sciences, Biology & Biochemistry, and Plant & Animal Science indicate the lowest (18.6%, 21.5%, and 26.6% each). A similar trend can be identified in South Asia: Immunology comes instead of Physics as a category of a highest average change rate and Biology & Biochemistry is replaced by Mathematics as a category of a lowest average change rate. Sub-Saharan Africa is slightly different, and Immunology, Environment, Biology & Biochemistry show the highest average change rates (70.2%, 38.7%, and 34.8% each). By contrast, Materials Science, Pharmacology, and Mathematics have the smallest average rates (7.3%, 8.6%, and 8.6% each).

As described in the above, the structure of categories and the growth rate of each category vary according to income level and region. In the meantime, Clinical Medicine, Plant & Animal Science, Agricultural Sciences, and Environment account for a large share in the low-income countries and Sub-Saharan Africa, and the growth rate of Environment is high. These findings suggest that research activities focused on themes closely related to regional characteristics are conducted in these countries and the region.

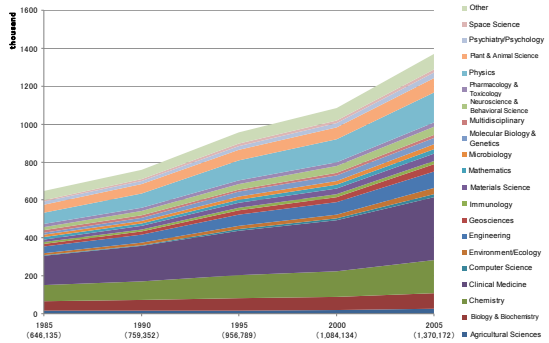
Table/Chart 15　Category breakdown of sources (by income level)



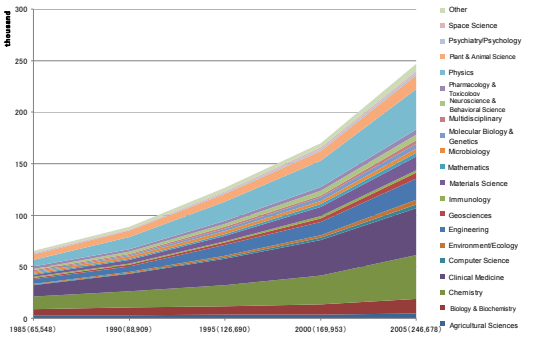

Table/Chart 16　Category breakdown of sources (by region)



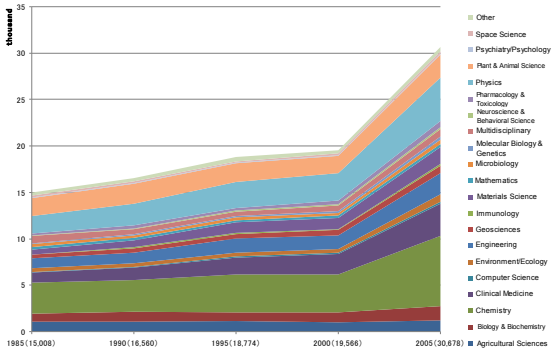
Table/Chart 17　Movements in the number of sources by category (certain regions)



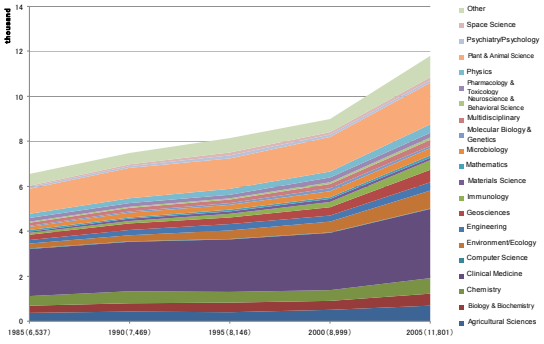

Entire world




East Asia & Pacific




South Asia




Sub-Saharan Africa

## 3.3 Characteristics of international coauthorship

Detailed case studies with a focus on international coauthorship will be conducted in the following chapter. Prior to it, this section first analyzes the world trend of international joint papers. Cross tabulation between two countries based on the NSI 2006 data is rather intricate; thus, we selected 103 countries whose average number of sources per year is more than 100 as targets based on the data compiled by the National Institute of Science and Technology Policy from the WoS data between 1998 and 2007.

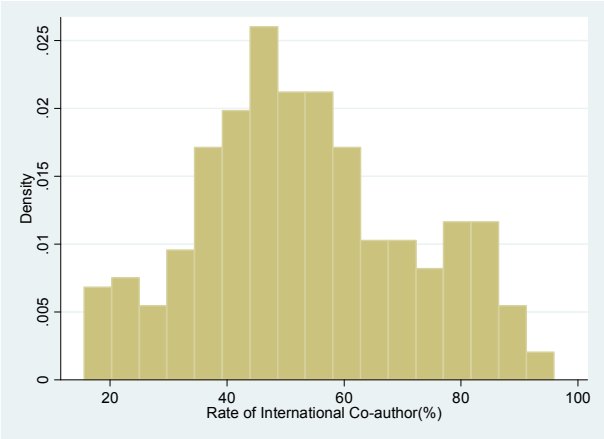
### 3.3.1 Movements in the international coauthorship rate and regional characteristics

Table/Chart 18 shows the frequency distribution of accumulated international coauthorship rates of each country between 1998 and 2007. The first mode (the largest number of countries, or the peak value) can be identified at around 50%, and the second mode at 80%. Table/Chart 19 shows a comparison of international coauthorship rate of 1998 and 2007[10]. Both charts (1998 and 2007)

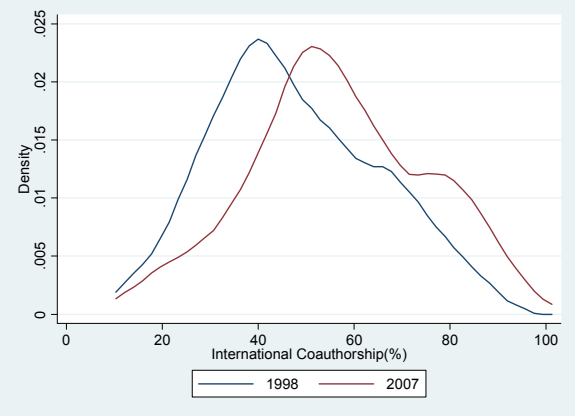
[10] Table/Chart 19 is based on kernel density estimator for better comparison of the movements. A histogram as shown in Table/Chart 18 might change if class value is modified. In the meantime, kernel density estimator in Table/Chart 19 shows density function centering on the observation value without fixing the center of the class (although a shape of the line chart will change according to bandwidth of the observation value). If observation value Xi (i.e., i=1… n) is obtained, kernel density estimates at X can be calculated based on the following formula. “K” means kernel function and we use the common Epanechnikov kernel for this analysis.

show a similar shape such as having two peaks. The chart of 2007 has a slightly longer tail of the coauthorship rate in the left compared with 1998, yet no major difference can be seen in the shape in general. Although the lowest international coauthorship rate[11] is almost the same for both 1998 and 2007, the rate for 2007 as a whole is shifted toward the right compared with 1998. Therefore, it is found that the international coauthorship rate is on the increase for these 10 years.

Table/Chart 18 Distribution of the international coauthorship rate (yearly accumulation between 1998 and 2007)




Table/Chart 19 Movements in the international coauthorship rate (1998 and 2007)




Table/Chart 20 shows regional international coauthorship rate per country/year, and countries that constitute each region are listed in Table/Chart 21[12]. The peak of the international

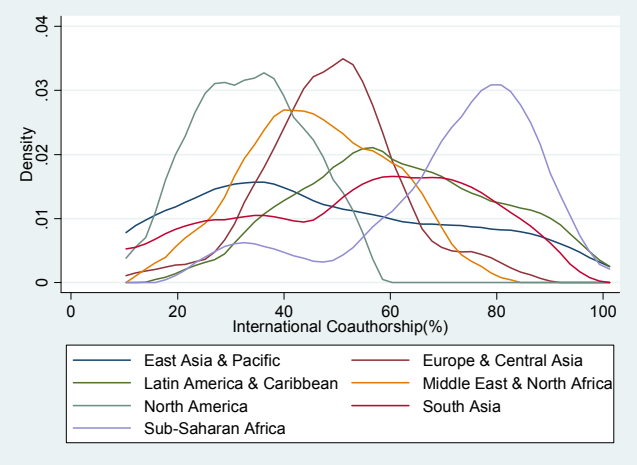
$$\hat{f_k}(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - X_i}{h}\right)$$

[11] Countries with the lowest international coauthorship rates are as follows in ascending order of the rate: India (15.54%), Taiwan (15.98%), Japan (16.51%), and Turkey (17.99%) in 1998; Turkey (15.96%) and India(19.67%) in 2007.

[12] It should be noted that Table 21 targets 103 countries with an annual average of more than 100 sources and has a little difference from the classification targeting 161 countries (Table/Chart 8): a change in the number of countries is disproportionate (e.g., Number of countries included in Sub-Saharan Africa is decreased from 42 to 15).

coauthorship rate is different from region to region as shown in Table/Chart 20. For instance, the peak of Sub-Saharan Africa is at about 80%, which is the highest among the seven regions, while North America reached a peak at around 30%, which is the lowest. Europe & Central Asia reach a peak at some 50%. East Asia & Pacific in which Japan is included does not have a prominent peak. The peaks in Table/Chart 18 may be explained by regional difference of the international coauthorship rate based on these characteristics. For example, the peak around at 80% may be affected by that of Sub-Saharan Africa, while Europe & Central Asia with many member countries seemed to have an influence on the peak near 50% (highest density).

Table/Chart 20　Regional distribution of the international coauthorship rate (yearly accumulation between 1998 and 2007)




Table/Chart 21　Countries constituting each region

| Region | East Asia & Pacific | Europe & Central Asia | | Latin America & Caribbean | Middle East & North Africa | North America | South Asia | Sub-Saharan Africa |
|---|---|---|---|---|---|---|---|---|
| Number of countries (Total 103) | 12 | 41 | | 15 | 13 | 2 | 5 | 15 |
| Member countries | Japan | United Kingdom | Ireland | Brazil | Israel | United States | India | South Africa |
| | China | Germany | Romania | Mexico | Iran, Islamic Rep. | Canada | Pakistan | Nigeria |
| | Australia | France | Slovak Republic | Argentina | Egypt, Arab Rep. | | Bangladesh | Kenya |
| | Korea, Rep. | Italy | Slovenia | Chile | Saudi Arabia | | Sri Lanka | Tanzania |
| | Taiwan | Spain | Bulgaria | Venezuela | Morocco | | Nepal | Cameroon |
| | Singapore | Russian Federation | Croatia | Colombia | Tunisia | | | Ethiopia |
| | New Zealand | Netherlands | Belarus | Cuba | Algeria | | | Uganda |
| | Thailand | Sweden | Lithuania | Uruguay | Jordan | | | Zimbabwe |
| | Malaysia | Switzerland | Estonia | Peru | Kuwait | | | Senegal |
| | Indonesia | Poland | Iceland | Costa Rica | United Arab Emirates | | | Ghana |
| | Vietnam | Belgium | Armenia | Ecuador | Lebanon | | | Cote d'Ivoire |
| | Philippines | Turkey | Latvia | Panama | Oman | | | Malawi |
| | | Denmark | Uzbekistan | Jamaica | Syria | | | Botswana |
| | | Austria | Georgia | Trinidad and Tobago | | | | Burkina Faso |
| | | Finland | Cyprus | Bolivia | | | | Sudan |
| | | Greece | Kazakhstan | | | | | |
| | | Norway | Azerbaijan | | | | | |
| | | Czech Republic | Moldova | | | | | |
| | | Hungary | Luxembourg | | | | | |
| | | Portugal | Macedonia, FYR | | | | | |
| | | Ukraine | | | | | | |

### 3.3.2 International coauthorship rate and the relationship between the quantity and quality of sources

(1) Relationship between the international coauthorship rate and the number of sources

According to the regional analysis on international coauthorship rate in 3.3.1, there seems to be a correlation between the rate and the number of sources or the rate and income level. In order to analyze the correlation, we first indicate the top 10 and the last 10 countries in the annual average rate between 1998 and 2007 in Table/Chart 22. The number of sources in the top 10 countries is 500 or less on average per year and the international coauthorship rate varies from 89.7% in Bolivia to 76.8% in Ecuador. They are lower income countries or middle income countries in Latin America & Caribbean, East Asia & Pacific, or Sub-Saharan Africa. In the meantime, the last 10 countries include the U.S., Japan, and China, which have a substantial number of sources, and the rate varies from 17.5% in Turkey (lowest) to 32.6% in Brazil.

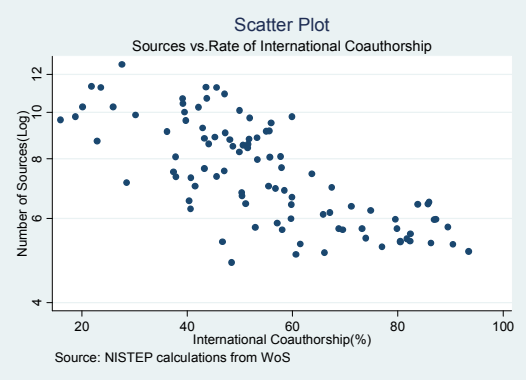
This indicates that the international coauthorship rate may be low if the number of sources is large or national income is high. Nonetheless, European countries are not included in the last 10 countries except Turkey. Thus, we consider that even within countries with many sources such as the U.K. and Germany, there are some countries whose international coauthorship rate is high compared with the last 10 countries shown in Table/Chart 22 due to regional unification.

Table/Chart 23 shows a scatter plot of the international coauthorship rate and the number of sources as well as the international coauthorship rate and GDP per capita (in purchasing power parity (PPP) equivalence). The table/chart indicates that the higher the coauthorship rate, the smaller is the number of sources, and we will speculate that there is a negative correlation between them. Reverse correlation can be seen between GDP and the international coauthorship rate to some extent, but their connection seems to be vaguer compared with that of the number of sources and the international coauthorship rate.

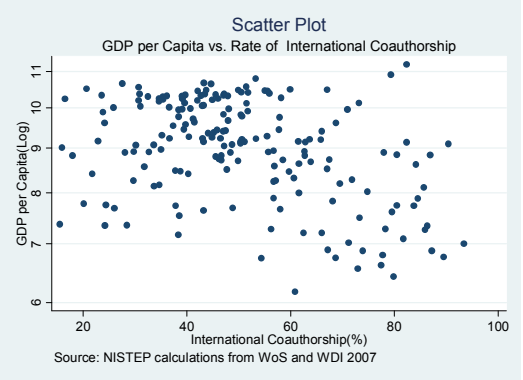
Table/Chart 22 International coauthorship rate (Left: Top 10 countries, Right: Last 10 countries)

| Ranking | Country | Sources | International coauthorship | Region | Ranking | Country | Sources | International coauthorship | Region |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Bolivia | 107 | 89.7 | Latin America & Caribbean | 103 | Turkey | 10,395 | 17.5 | Europe & Central Asia |
| 2 | Panama | 146 | 87.8 | Latin America & Caribbean | 102 | India | 22,314 | 18.3 | South Asia |
| 3 | Indonesia | 497 | 85.2 | East Asia & Pacific | 101 | Taiwan | 13,078 | 18.7 | East Asia & Pacific |
| 4 | Peru | 283 | 84.0 | Latin America & Caribbean | 100 | Japan | 76,302 | 20.5 | East Asia & Pacific |
| 5 | Burkina Faso | 112 | 83.1 | Sub-Saharan Africa | 99 | China | 50,472 | 23.1 | East Asia & Pacific |
| 6 | Tanzania | 276 | 80.8 | Sub-Saharan Africa | 98 | USA | 266,519 | 25.0 | North America |
| 7 | Vietnam | 438 | 80.7 | East Asia & Pacific | 97 | Iran, Islamic Rep | 3,228 | 25.1 | Middle East & North Africa |
| 8 | Uganda | 220 | 77.7 | Sub-Saharan Africa | 96 | Korea, Rep. | 19,774 | 25.1 | East Asia & Pacific |
| 9 | Senegal | 198 | 77.4 | Sub-Saharan Africa | 95 | Saudi Arabia | 1,540 | 32.6 | Middle East & North Africa |
| 10 | Ecuador | 154 | 76.8 | Latin America & Caribbean | 94 | Brazil | 14,036 | 32.6 | Latin America & Caribbean |

Table/Chart 23　Relationship between the international coauthorship rate and the number of sources/GDP per capita (2006)




(a)　Number of sources and the international coauthorship rate

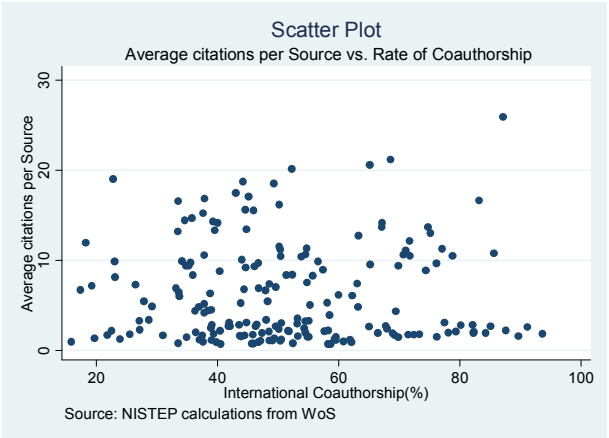



(b)　GDP per capita and the international coauthorship rate

(2)　Relationship between the international coauthorship rate and average citations per source

It is pointed out that in countries with a substantial number of sources, including Japan, the U.S., and the U.K., international joint papers receive a larger average number of citations than papers written by researchers in a single country (*Saka & Kuwahara, 2008*). This indicates that the average citations that a country with a high international coauthorship rate receives may be higher than that of a country with a low coauthorship rate. We analyzed the correlation between the average citations and the international coauthorship rate for individual countries, including the developing countries. Table/Chart 24 shows the correlation between the average citations and the international coauthorship rate in 2000. The category structure of papers for each country also needs to be considered, yet no definite relationship can be indicated in the simple scatter plot targeting 103 countries.

Table/Chart 24　Relationship between average citations and the international coauthorship rate (2000)



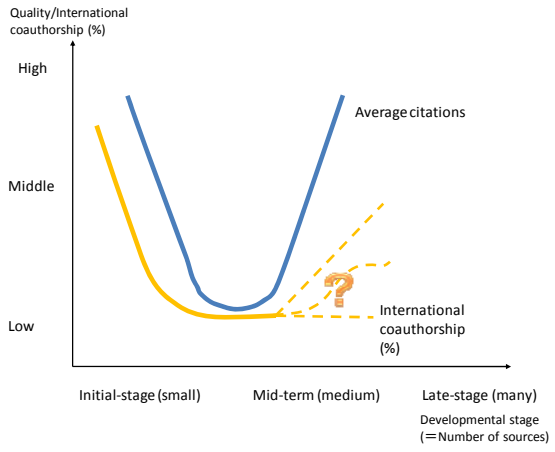
Column 3: A discussion on the developmental process of academic publishing

For this discussion, we assume that the developmental process of academic publishing would be explained by the number of sources. It is expected that the quality of papers is maintained at a certain level (often highly) in early stages of development, and then drops once and rises again as the stage goes up (i.e., as the number of sources increases), which shows a "U" curve. This process can be explained by generalization of academic publishing. That is, the quality of source remains constant when the number of sources is small because of limited access to international journals yet it will be diversified along with generalization (increased researchers and improved access to international journals due to reasons such as higher income), and the average quality will drop as a result. However, the average quality of papers would improve if the number of researchers and investments to research activities increase and other conditions remain the same.

In the meantime, the relation between the developmental process of publishing papers and international coauthorship rate is more complicated. The international coauthorship rate is high in the initial developmental stage where the number of sources is small because it is not sufficient in terms of quality or quantity for domestic researchers to present articles in international journals by themselves. However, the international coauthorship rate goes down if domestic researchers become able to publish papers with their own resources as domestic research activities become active and the developmental stage goes up (e.g., domestic publishing will increase if researchers who have worked abroad return to their home countries). In a situation like Europe, where countries in advanced developmental stages are geographically close to each other and working toward political and economic integration, researchers can easily move within the region and can enjoy an environment conducive to joint research. Therefore, the international coauthorship rate may increase, and globalized research activities can boost international coauthorship, regardless of region.

As shown in Table/Chart 25, the quality of papers is expected to show a "U" curve according to the developmental stage of academic publishing (number of sources) of each country. The international coauthorship rate declines along with the degree of development of research activity to some extent, which, however, seems to follow a complicated way depending on international cooperation, including relations with adjacent countries, or on the level of socioeconomic stability.

Table/Chart 25 Conceptual chart of developmental process of academic publishing



# 4. Academic publishing in six developing countries (case study)

We analyzed global academic publishing in the previous chapter. In this chapter, we select several developing countries as samples and attempt to conduct a detailed analysis on the ownership of sources and selection of countries where coauthors belong to, considering the characteristics of these countries.

## 4.1 Selection of countries

In this chapter's case studies, we attempt to select and analyze some developing countries with a certain number of researchers who are capable of conducting research activities independently. It is estimated that those countries have a certain number of sources according to the analysis in Chapter 3. Nonetheless, a definition of "certain number" is not clear; thus, we used the condition that a country published more than 5,000 papers between 1981 and 2006[13] here. On this condition, the target countries were narrowed down to 66 countries and then to around five countries.

Table/Chart 26 shows those 66 countries by income level. The composition of these countries is close to that of 161 countries in Table/Chart 8 in that the number of high-income OECD countries is 23 (24 in Table/Chart 8). However, Table/Chart 26 has a smaller number of low-income countries (six compared with 52) and a smaller percentage of other income level countries (about 40% compared with 60%). Table/Chart 27 describes an overview of 2005 in two categories: countries with more than 5,000 sources and those with less than 5,000. The first category shows a higher level of income, a larger population and higher education enrollment than the second. The average number of sources is 20,532 in the first category, which is about 129 times that of the second (159). The average number of citations of the first category is 2.0, which is about 1.2 times that of the second (1.7).

Table/Chart 28 is a scatter plot of indices concerning academic writing and GDP per capita of the 66 countries in 2005. The number of sources, average citations, and the international coauthorship rate are indicated in (a), (b), and (c) respectively as indices related to academic writing. Plot (d) indicates a relation between the average number of citations and the international coauthorship rate. Plot (a), (b), and (c) show that around 10 low-income countries are more widely scattered than the other countries. A spread can be identified especially on the left side of Table/Chart 28 (b); low-income countries with relatively large average citations are dispersed apart from the trend for other countries. Specifically, these consist of eight countries: five low-income countries (Bangladesh, India, Kenya, Nigeria, and Pakistan) and three lower-middle income nations (China, Indonesia, and Philippines). Indonesia and Kenya show their high international coauthorship rate in (d).

We chose six nations out of these 66 by first selecting low-income countries and then selecting two for each region from them considering the regional balance: Indonesia and Philippines for Southeast Asia, Bangladesh and Pakistan for South Asia, and Kenya and Nigeria for Sub-Saharan Africa. China and India were excluded because they were considered distinct from

[13] *National Institute of Science and Technology Policy, 2005* excludes countries with less than 1,000 sources in 2001 for its study on the growth rate of sources between 1991 and 2001.

the other developing countries. The locations of these six countries in the world and their socioeconomic indices are shown in Table/Chart 29.

With regard to socioeconomic indices, the average life expectancy of the two African nations is low (the average of two nations in each region is as follows: 69.5 in Southeast Asia, 64.0 in South Asia, and 50.0 in Africa), while the adult literacy rate is low in the two South Asian countries (90.5% in Southeast Asia, 53.8% in South Asia, and 71.4% in Africa). In the meantime, Indonesia and Nigeria mainly export petroleum and natural gas, which indicates that they rely on natural resources. Japan is the key market for the two Southeast Asian nations, while the U.S. is the major market for the countries excluding Kenya. In terms of import, the connection between China and the target countries excluding the Philippines can be identified. The two South Asian countries and two African countries used to be a colony of The U.K., which may have left a sort of influence on the national systems including higher education.

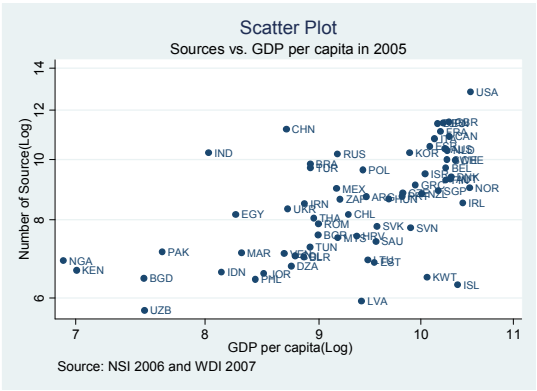
Table/Chart 26　Breakdown of the selected 66 countries (by income level)

| Income level | Low income | Lower middle income | Higher middle income | High income OECD | High income Non-OECD |
|---|---|---|---|---|---|
| Number of countries (Total 66) | 6 | 19 | 14 | 23 | 4 |
| Member countries | Bangladesh | Algeria | Argentina | Australia | Israel |
| | India | Belarus | Chile | Austria | Kuwait |
| | Kenya | Brazil | Croatia | Belgium | Singapore |
| | Nigeria | Bulgaria | Czech Republic | Canada | Slovenia |
| | Pakistan | China | Estonia | Denmark | |
| | Uzbekistan | Colombia | Hungary | Finland | |
| | | Egypt, Arab Rep. | Latvia | France | |
| | | Indonesia | Lithuania | Germany | |
| | | Iran, Islamic Rep. | Malaysia | Greece | |
| | | Jordan | Mexico | Iceland | |
| | | Morocco | Poland | Ireland | |
| | | Philippines | Saudi Arabia | Italy | |
| | | Romania | Slovak Republic | Japan | |
| | | Russian Federation | Venezuela, RB | Korea, Rep. | |
| | | South Africa | | Netherlands | |
| | | Thailand | | New Zealand | |
| | | Tunisia | | Norway | |
| | | Turkey | | Portugal | |
| | | Ukraine | | Spain | |
| | | | | Sweden | |
| | | | | Switzerland | |
| | | | | United Kingdom | |
| | | | | United States | |

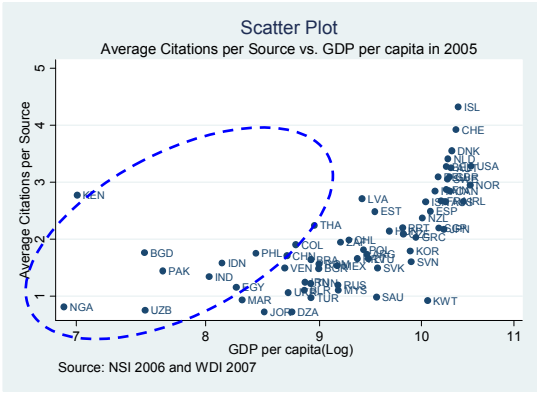
Table/Chart 27　Characteristics of academic publishing in 66 countries (2005)

| Item \ Segment | Sources >= 5,000 | Sources < 5,000 |
|---|---|---|
| Number of countries | 66 | 95 |
| Income per capita (in PPP) (US$) | 15,904 | 4,606 |
| Populations (thousand) | 80,400 | 9,803 |
| Sources | 20,532 | 159 |
| Citations | 55,253 | 270 |
| Average citations per source | 2.03 | 1.70 |
| High-education enrollment rate | 33.75 | 15.03 |

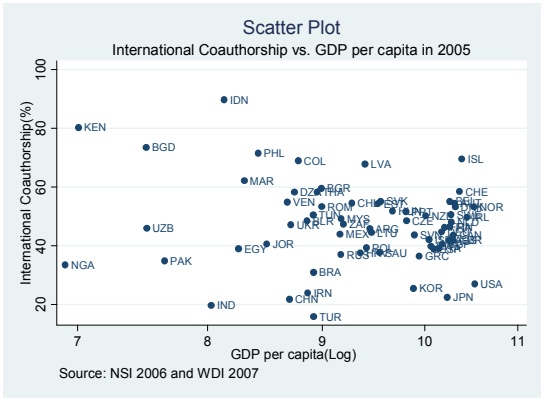
Table/Chart 28　Relationship between academic publishing indices and an economic index for 66 countries



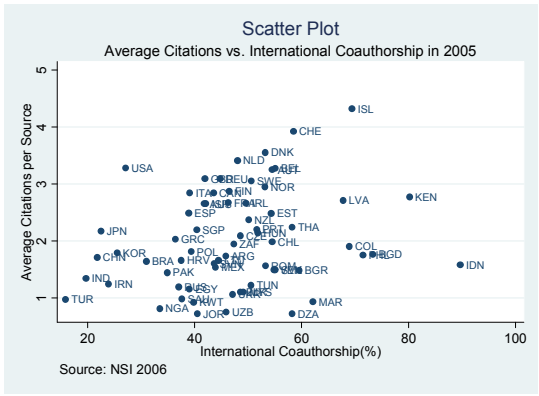

(a)　Number of sources and GDP per capita




(b)　Average citations and GDP per capita GDP

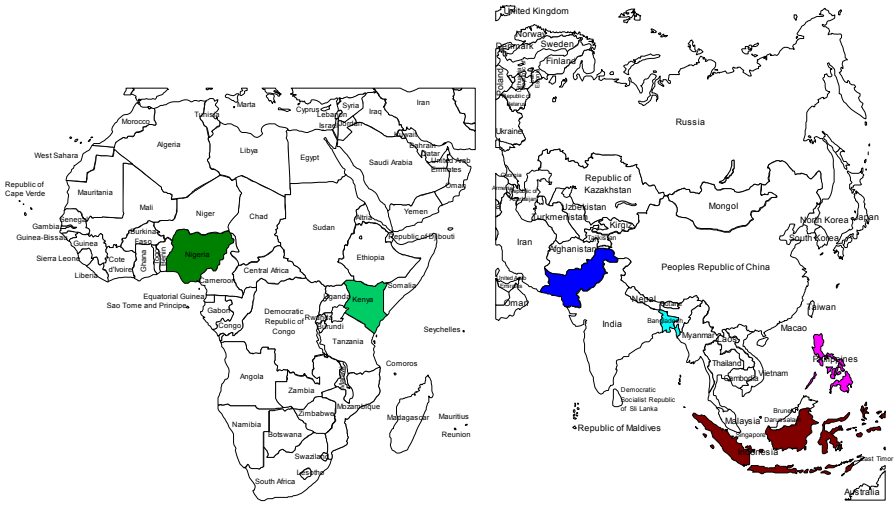



(c)　International coauthorship rate and GDP per capita




(d)　Average citations and the international coauthorship rate

Table/Chart 29　Details of target six countries (Above: Map, Below: Socioeconomic indices)



| Country | Population (in thousands) | GDP per capita PPP (US$) | Average life expectancy | Tertiary enrollment rate (second education) | Adult (15-year old or more) literacy | Language | Religion | Year of independence | Former colonial power |
|---|---|---|---|---|---|---|---|---|---|
| Indonesia | 220,600 | 3,209 | 68 | 62.22 | 88.5% (2003) | Indonesian | Islam (88.6%), Christian (8.9%) | 1945 | Netherlands |
| Philippines | 83,054 | 2,956 | 71 | 84.79 | 92.6% (2000) | National language: Tagalog, Official language: Tagalog and English | Catholic (83%), other Christian (10%), Islam (5%) | 1946 | Spain (1521～1898), USA (1898～1946) |
| Bangladesh | 155,800 | 1,068 | 63 | 46.17 (2000) | 52.5% (2005) | Bengali (national language) | Islam (89.7%), Hindu (9.2%) | 1971 | Pakistan |
| Pakistan | 141,800 | 2,184 | 65 | 28.58 | 55.0% (2006/2007) | Urdu (national language) | Islam (national religion) | 1947 | British India |
| Kenya | 34,256 | 1,375 | 53 | 48.21 | 73.6% (2000) | Swahili, English | Traditional religions, Christian, Islam | 1963 | United Kingdom |
| Nigeria | 131,500 | 1,520 | 47 | 32.44 | 69.1% (2004) | English (official language), ethnic languages | Islam (North), Christian (South East), Traditional religions (all areas) | 1960 | United Kingdom |

| Country name | Major exporting goods | Major importing goods | Major importers | Major exporters |
|---|---|---|---|---|
| Indonesia | Petroleum/Gas (21%), Animal & Plant oil (9%), Mineral fuels (8%) | Petroleum/Gas (23.7%), general machineries (14%), steel (6%) | Export: EU (14%),Japan (13%), USA (12%) | China (15%), Japan (14%), Singapore (11%) |
| Philippines | Electronic appliance (58.1%, mostly semi-conductors), Motor vehicles and others | Electronic appliance (35.3%, mostly semi-conductors), electronic parts, Power generators and others | USA (16.7%), Japan (15.7%), China (11.1%) | USA (12.7%, Japan (11.6%), Singapore (10.5%) |
| Bangladesh | Apparel (36.6%), Knitwear (39.2%), fishery products (3.8%) | Petroleum products (10.6%), Fabrics (9.7%), Machineries/equipments (8.5%) | USA, Germany, UK, France | India, China, Singapore |
| Pakistan | Fabrics, Leather-goods, synthetic fiber apparel | Petroleum products, Crude oil, Automobiles | USA, UAE, China | Saudi Arabia, China, UAE |
| Kenya | Tea, Plants, Coffee | Machineries, Petroleum products, Automobiles | Uganda, UK, Tanzania | UAE, India, China |
| Nigeria | Fuels, Natural gas, Industrial products | Foods, Fuels/Energy | USA, Brazil, Spain | China, USA, UK |

Source: GDP, Average life expectancy, gross enrollment rate for secondary education: WDI 2007

Other: Regional situations, Ministry of Foreign Affairs: http://www.mofa.go.jp/mofaj/area/index.html

## 4.2 Framework and methodology of the survey

### 4.2.1 Framework of the survey

First of all, we indicate the characteristics of academic publishing, including the number of institutes delivering papers and research fields (categories) of the target six countries. Secondly, we conduct an analysis focusing on international coauthorship. Specifically, we clarify the characteristics of the owner countries of sources in the target countries and those of their international key coauthor countries, and attempt to understand the relation between

international coauthorship and fund flows/ acceptance of overseas students. Subsequently, we analyze movements in the share of joint writing with the target countries and key coauthors such as the U.S. and Japan, as well as the characteristics of Japan's coauthorship as compared with the U.S. Lastly, we overview a biography of 30 researchers who have a large number of sources in the target countries.

### 4.2.2 Methodology of the survey

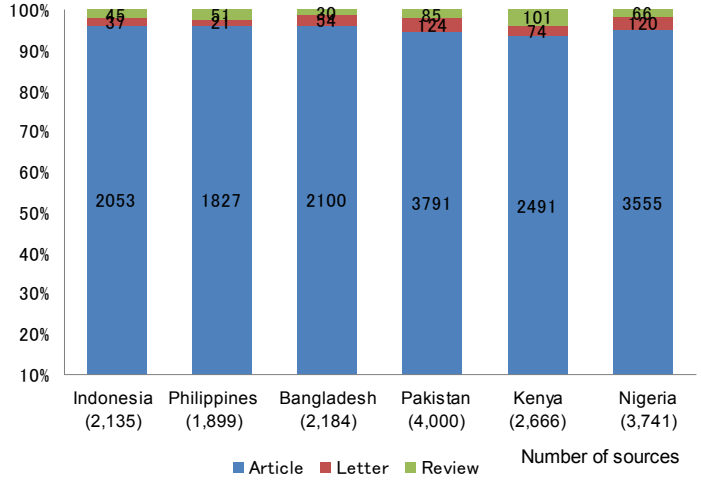
#### (1) Database

WoS data is used since it has information concerning reprint addresses.

#### (2) Data outline

We target only articles so as to analyze contribution to knowledge creation. Articles accounted for about 94–96% among four kinds of literature (i.e., article, letter, note, and review) in the six countries between 2001 and 2005 (Table/Chart 30), which is higher than the global average (91.6%) indicated by *Saka & Kuwahara, 2008*.

Table/Chart 30 Breakdown of sources by type




Note: None of them have notes.

#### (3) Period of analysis

The analysis targets a period between 1998 and 2008. This is because of a low deficit rate of C1 (address for identifying the country where the institute to which an author belongs to exists) or RP (reprint address) during the period. For Indonesia, for example, the maximum deficit rate of C1 or RP between 1979 and 1997 was 18.0% and 30.0% respectively, while the rate between 1998 and 2008 was less than 1%[14].

[14] Either C1 or RP may be missing, yet there is no data missing both of them.

(4) Definition of terms

Ownership of sources:

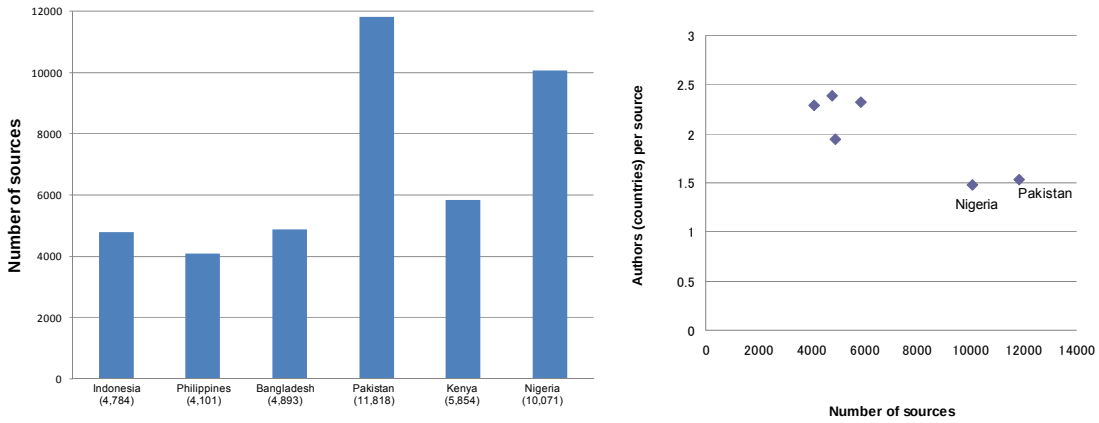
Assuming that RP includes the contact information of the person who took a lead in writing the paper/conducting the research or who is in charge of the content of the paper, we decided that the country indicated in the reprint address of a source has the ownership of the source. A reprint address includes one contact (one country) per source; thus, a total number of reprint addresses should comply with that of all sources.

## 4.3 Outline of academic publishing

(1) Numbers of sources and countries of origin

Table/Chart 31 shows the number of sources published by the target six countries between 1998 and 2008. Pakistan and Nigeria published over 10,000, while the other four countries produced around half that number of sources (e.g. 4,101 in the Philippines and 5,854 in Kenya). With regard to Pakistan and Nigeria, which have a larger number of papers among the six countries, the sources' origin (number of countries engaged in joint writing) consists of about 1.5 countries; while those of the other four countries are two or more.

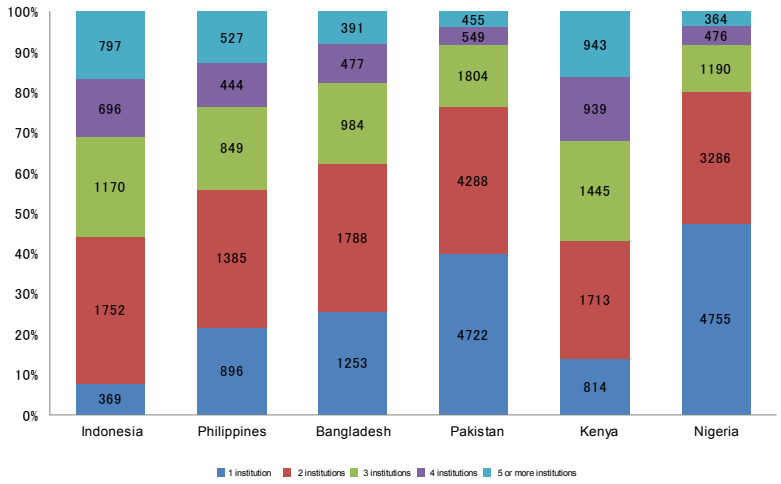
Table/Chart 31 Numbers of sources and countries of origin (Right: Number of sources, Left: Average number of countries of origin)




(2) Number of institutes publishing papers

As shown in Table/Chart 32, scholarly papers tend to be written by a single institute in Pakistan and Nigeria, which have a larger number of sources among the six countries, compared with the other four countries. It is expected that the higher the international coauthorship rate, the larger is the number of institutes engaged in writing; thus, the number of institutes is different depending on international coauthorship.

Table/Chart 32　Number of institutes publishing sources



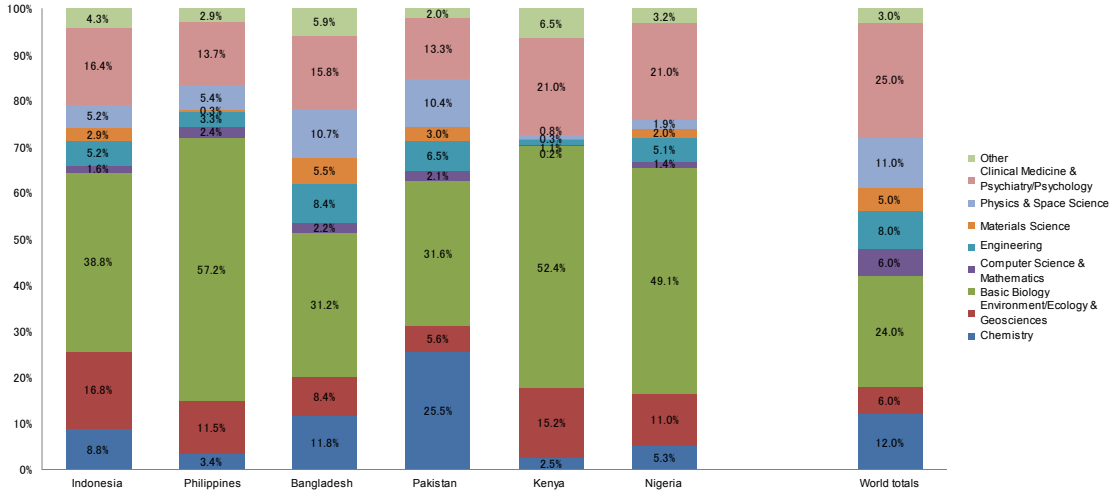

## (3)　Subject categories of sources

Table/Chart 33 shows the breakdown of the subject categories of sources in the six countries between 2001 and 2005 for eight fields. Compared with the breakdown of the categories of global sources as shown in *Saka & Kuwahara, 2008*, sources in the fields of Basic Biology or Environment/Ecology/Geoscience are commonly large in the six countries. An analysis focusing on the difference between them indicates that Chemistry assumes a dominant position in Pakistan and that the shares of Physics & Space Science and Engineering are small in four countries excluding two South Asian countries (Bangladesh and Pakistan).

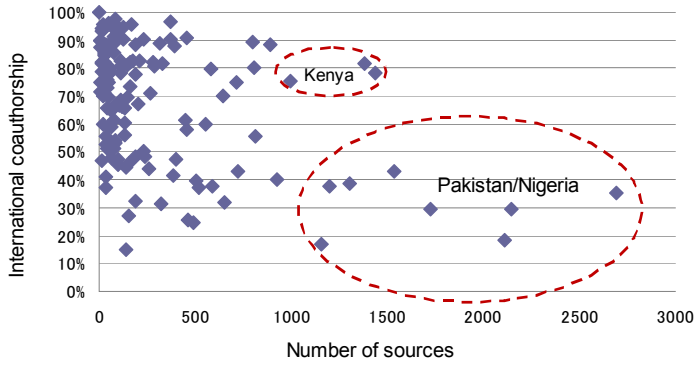
Table/Chart 34 is a scatter plot concerning the international coauthorship rate and the number of sources in 22 categories. We can see a tendency that the international coauthorship rate is low in the fields with a large number of sources. The field of Plant & Animal Science, as well as Clinical Medicine, in Pakistan, Kenya, and Nigeria has more than 1,000 sources, and Kenya especially shows a higher international coauthorship rate than the other two countries.

We classified sources of the six countries into 22 categories and selected the top three categories in the number of sources. Table/Chart 35 shows the relation between the average citations and the number of sources for these categories. The table indicates a tendency that the larger the number of sources, the smaller is the number of average citations. The trend can be identified especially in Clinical Medicine, which is common in the top three categories. Table/Chart 7 showed that the average citations per source vary according to category, yet the number of sources may also have an impact on average citations in each category.

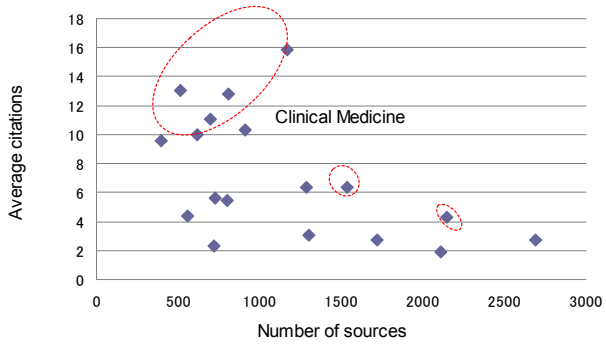
Table/Chart 33　Category breakdown of sources




Table/Chart 34　International coauthorship rate and the number of sources by category




Table/Chart 35　Relationship between average citations and the number of sources (specific categories)




## (4)　Movements in the number of sources and their backgrounds

Table/Chart 36 shows movements in the number of sources and socioeconomic indices (GDP per capita, average life expectancy, and populations) of the six target countries between 1980 and 2008. The table shows differences in trends between countries. The number of sources, although varying slightly by country, steadily increased in all the countries except Nigeria over the target

period. Among them, Pakistan has shown a steep increase since 2000. The number of sources in Nigeria was more than three times larger than those of the other five countries in 1980, but began to decline in 1986 and took 20 years (until 2006) to return to the level before the decline. The following are the characteristics of movements of socio-economic indices[15].

GDP per capita: Indonesia shows the greatest increase among the six countries, while a slow rise can be identified in the Philippines, Pakistan, and Bangladesh. Kenya and Nigeria remain sluggish.

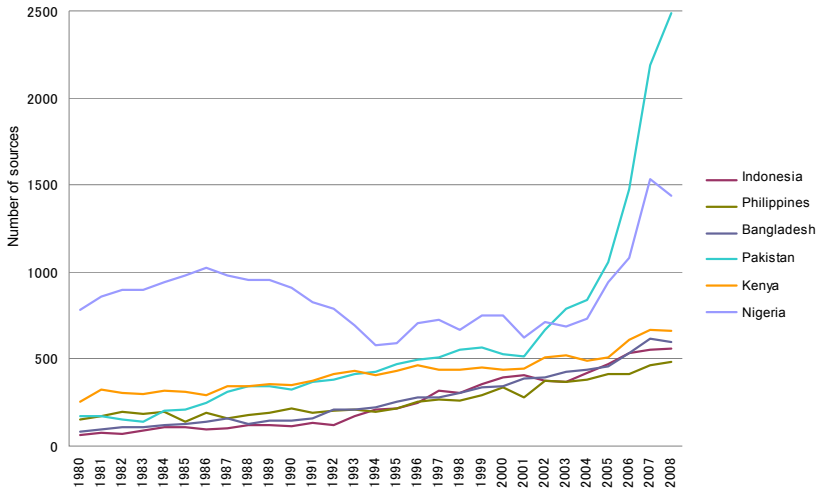
Average life expectancy: Two African countries show a decrease or slump. Average life expectancy in Indonesia, Philippines, and Pakistan was around 60 years old in 1980, which converged around 70 years old in 2000. On the other hand, Kenya dropped from the 60s to the 50s in the same period, which is almost a 10-year decrease, and Nigeria remains at the 40s for more than a quarter-century.

Populations: Although differing in the growth rate, all of the six countries kept growing.

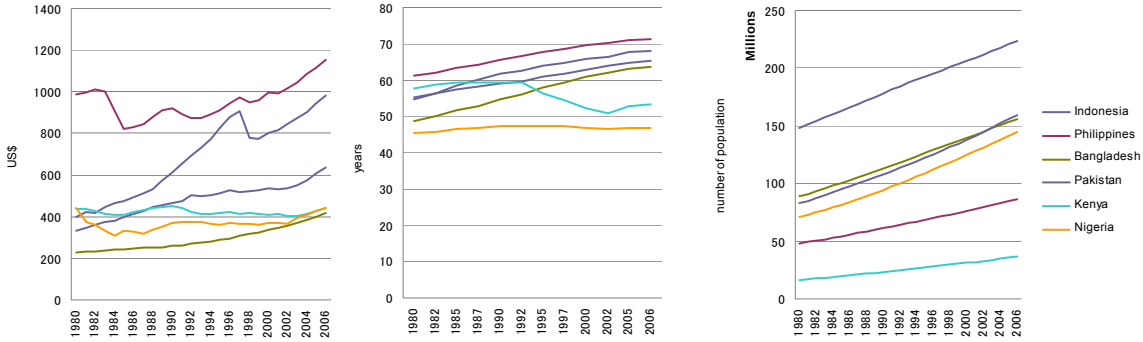
Generally speaking, GDP and average life expectancy are expected to increase in the long term; thus, their decrease or slump would mean that not only peoples' lives but also research environment (e.g., at universities) deteriorated and that the countries are experiencing an outflow of researchers to overseas. It is not difficult to imagine that this is the factor which causes reduction or stagnation of the production of academic papers in Nigeria. In the meantime, it is not easy to explain the increase in the number of sources (e.g., Pakistan since 2000) based on those macro socioeconomic indices. Since indeces directly related to R&D have many defects, it is not easy to perform a chronological comparison of six countries. However, for instance, R&D investment accounts for 0.07% of the GDP in Indonesia in 2000, while the equivalent figure for Pakistan is 0.13%, which is approximately two times higher than that of Indonesia. For Pakistan, the percentage increased to 0.43% in 2005, which shows about a 3.3 time-increase. These findings suggest that there is a need to conduct detailed analysis on the background of the growth of sources by introducing a new index or otherwise, in addition to the background of the increased rate of investment.

[15] Data available concerning 2001 and 2005 showed that the gross enrollment rate for higher education was as high as around 30% in the Philippines, followed by Indonesia (about 15%) among six countries. On the other hand, the rate in Bangladesh, Pakistan, and Kenya was less than 10%.

Table/Chart 36　Movements in the number of sources and socioeconomic indices (Above: Number of sources, Below: Socioeconomic indices)




Source: WoS




(a) GDP per capita　(b) Average life expectancy　(c) Population　Source: WDI 2007

## 4.4 Characteristics of international coauthorship

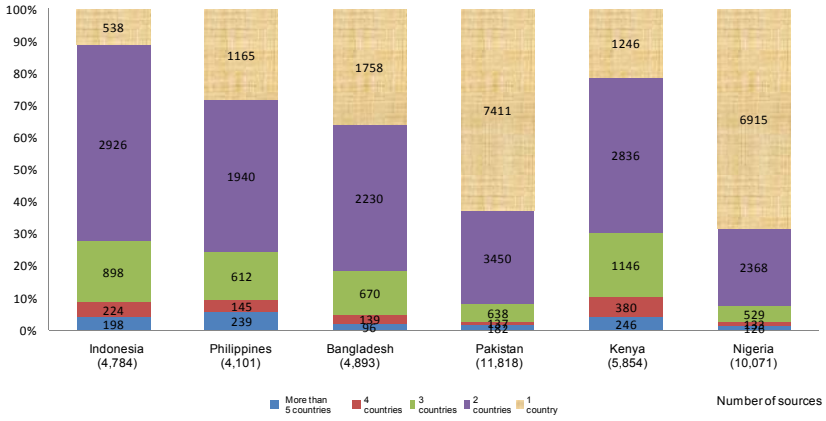
First, we analyze the characteristics of international coauthor countries to each targeting country and of the countries that have the ownership of sources. Secondly, we study the relation among fund flow, acceptance of overseas students, and selection of coauthors.

### 4.4.1 International coauthorship and ownership of sources

#### (1) International coauthorship

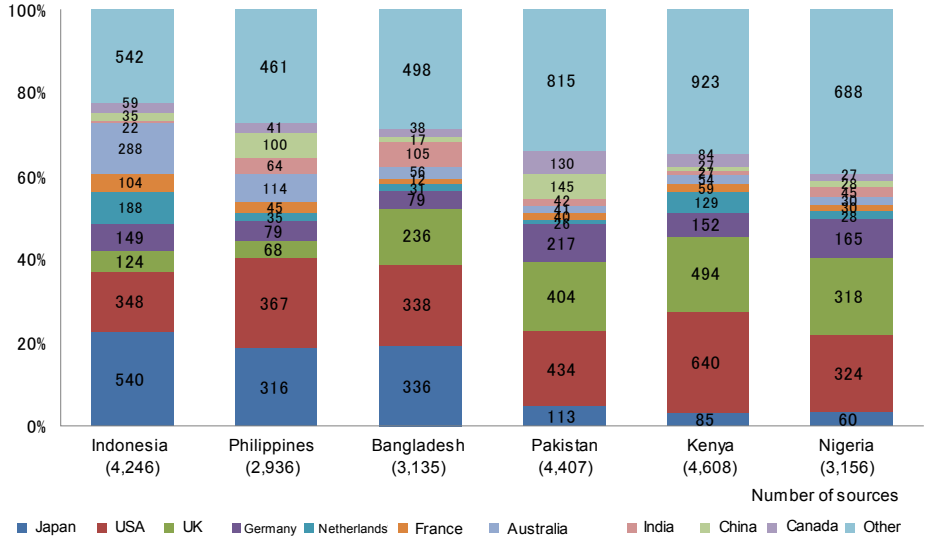
The international coauthorship rate is high in countries with fewer sources, while it is low in countries with many sources. The rate is as high as 70−90% in four countries with relatively small number of sources among the six, while it is relatively lower than the above four countries, at around 30−40%, in Pakistan and Nigeria, which have many sources comparatively. Indeed, international coauthorship rate in those six countries is higher than that of the worldwide sources between 2001 and 2005 (18.8%) (*Saka & Kuwahara, 2008*).

Table/Chart 37　Number of countries engaged in academic publishing




Table/Chart 38 shows the number of sources that belong to the major international coauthor countries based on fractional counting for the six target countries. The U.S. accounts for a large share in all the six countries, while Japan has a large share in two Southeast Asian countries (Indonesia and Philippines) and Bangladesh. The U.K. has a relatively higher share in countries other than these two Southeast Asian countries than it has in these two. A tendency to publish joint papers with major countries that are geographically close can be identified as well: Australia has a large share in Indonesia and the Philippines, which are geographically closer compared with the other four countries, and India shows that they have a substantial number of joint papers with Bangladesh.

Table/Chart 38　Share of sources belonging to international coauthor countries



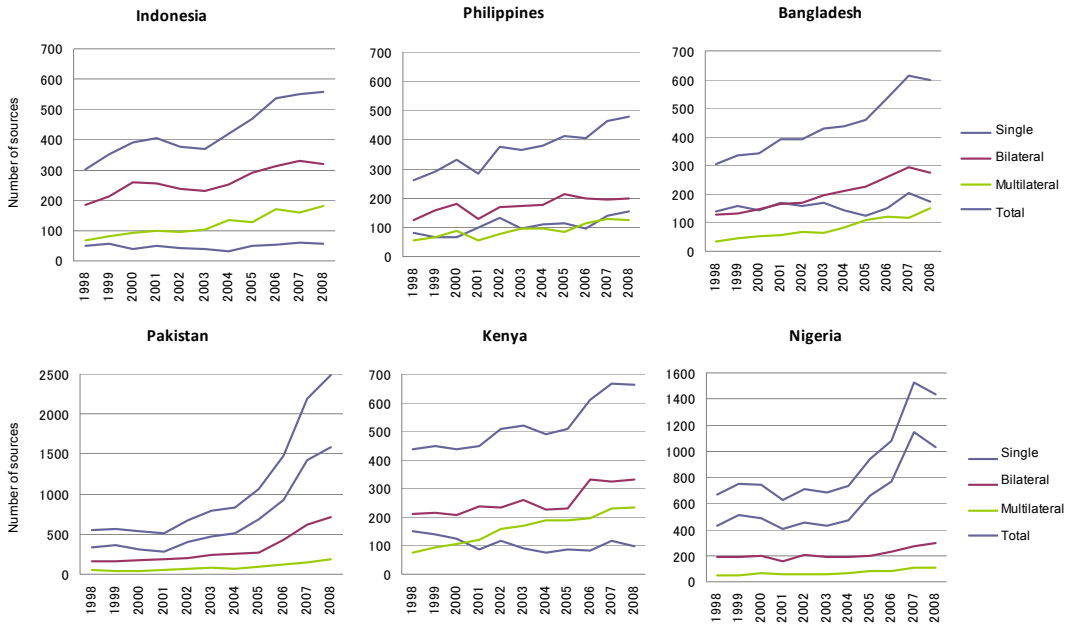

Note:　We selected the top 15 nations in the number of sources coauthored with the given target country, and then chose 10 major coauthor nations common for all the target countries.

## (2)　Movements in the number of countries engaged in international coauthorship

Table/Chart 39 indicates movements in the number of sources of the six target nations by country of origin (classification by the number of countries, under single, bilateral, and multilateral nations). Pakistan and Nigeria, which have many sources, show that they have the

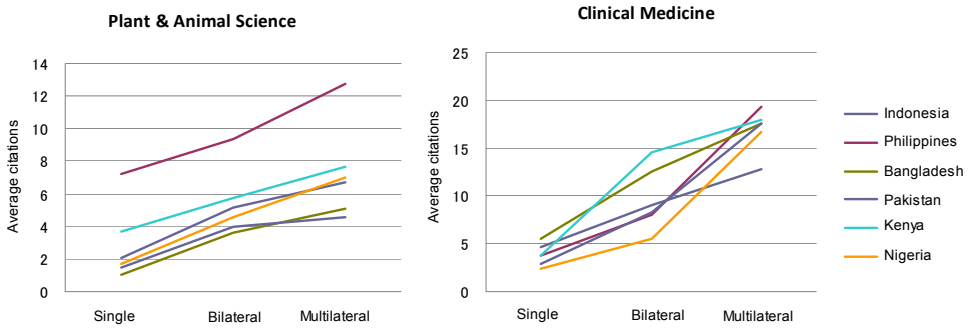
largest number of papers written by a single nation, and that the growth rate of this kind of papers is high. For Pakistan, sources written by two countries have shown a rapid growth since 2005 compared with those produced by more than three countries. The other four countries with a smaller number of sources indicate that most sources were published by two countries (excluding Bangladesh in 1998 and 1999). Among them, Indonesia, Bangladesh, and Kenya show that the number of sources written by multiple countries increased, while sources published by a single nation remained sluggish or slowed down.

Table/Chart 39 Movements in the number of countries engaged in academic publishing




The difference of the number of coauthor countries might be related to the quality of papers. We thus analyzed the relation between the number of countries writing papers (country of origin) and the quality of papers. Both Plant & Animal Science and Clinical Medicine are commonly included in the top three categories with a large number of sources among the six countries. Table/Chart 40, indicating trends in the average number of citations for each category of the number of coauthor countries, shows a common tendency for six countries that average citations grow as the number of coauthors increases.

Table/Chart 40　Average citations and the number of international coauthors (Right: Plant & Animal Science, Left: Clinical Medicine)




## (3)　Ownership of sources

As shown in Table/Chart 41, the source ownership rate[16] is as high as around 80% in Pakistan and Nigeria with many sources (78.4% and 79.0%, respectively), while it is as low as about 30% in Indonesia (exactly 28.3%). Among the top 10 countries in the share of reprint addresses of sources in the target six countries, the U.S., Japan, the U.K., and Germany are commonly included. For the Philippines, Pakistan, and Nigeria, China is included in the top 10 reprint addresses, although the percentage is small. India and Malaysia are included in the ranking of two countries. This indicates that several developing countries have the ownership of sources of the six target countries.

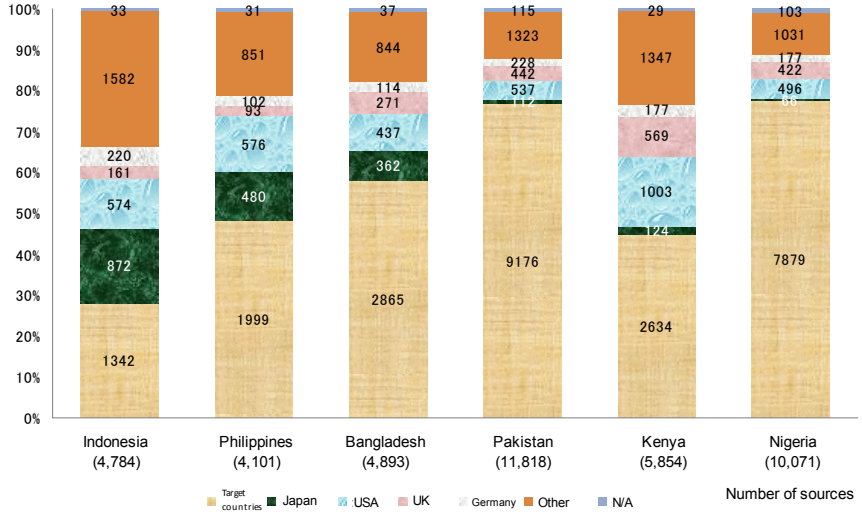
Table/Chart 42 shows the percentage of the target countries and four countries (Japan, U.S., U.K., and Germany) in reprint addresses. First, it was found that the percentage of target countries with many sources is high, and that the U.S. accounts for a large share in all the six target countries. Japan accounts for a large share in three geographically close countries (Indonesia, Philippines, and Bangladesh), while the U.K. shows a high percentage in countries to the west of Bangladesh, especially Kenya. As a result, we consider that the U.S. has the ownership of sources in the developing countries regardless of region, and that Japan tends to have many joint papers as well as ownership with geographically close developing countries.

Table/Chart 41　Breakdown of reprint addresses (top 10 countries)

| | Indonesia (4,751) | | Philippines (4,070) | | Bangladesh (4,856) | | Pakistan (11,703) | | Kenya (5,825) | | Nigeria (9,968) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ranking | Country | Percentage | Country | Percentage | Country | Percentage | Country | Percentage | Country | Percentage | Country | Percentage |
| 1 | Indonesia | 28.2% | Philippines | 49.1% | Bangladesh | 59.0% | Pakistan | 78.4% | Kenya | 45.2% | Nigeria | 79.0% |
| 2 | Japan | 18.4% | United States | 14.2% | United States | 9.0% | United States | 4.6% | United States | 17.2% | United States | 5.0% |
| 3 | United States | 12.1% | Japan | 11.8% | Japan | 7.5% | United Kingdom | 3.8% | United Kingdom | 9.8% | United Kingdom | 4.2% |
| 4 | Australia | 8.3% | Australia | 3.4% | United Kingdom | 5.6% | Germany | 1.9% | Germany | 3.0% | Germany | 1.8% |
| 5 | Netherlands | 6.3% | Germany | 2.5% | Germany | 2.3% | Canada | 1.3% | Netherlands | 2.6% | South Africa | 1.3% |
| 6 | Germany | 4.6% | China | 2.4% | India | 2.1% | China | 1.2% | Belgium | 2.2% | Italy | 1.3% |
| 7 | France | 3.8% | United Kingdom | 2.3% | Australia | 1.7% | Japan | 1.0% | Japan | 2.1% | Japan | 0.7% |
| 8 | United Kingdom | 3.4% | France | 1.3% | Sweden | 1.3% | Saudi Arabia | 0.7% | Canada | 1.8% | France | 0.5% |
| 9 | Malaysia | 1.9% | India | 1.2% | Malaysia | 0.9% | Italy | 0.7% | South Africa | 1.6% | China | 0.4% |
| 10 | Canada | 1.8% | Netherlands | 1.2% | Netherlands | 0.9% | Korea, Rep. | 0.5% | Switzerland | 1.4% | Cameroon | 0.4% |

[16] Country B's ownership rate in the target country (Country A) represents the share of Country A's papers whose reprint address information includes Country B.

Table/Chart 42　Share of major countries in the reprint address




## (4)　Share of the number and the ownership of papers in international coauthorship

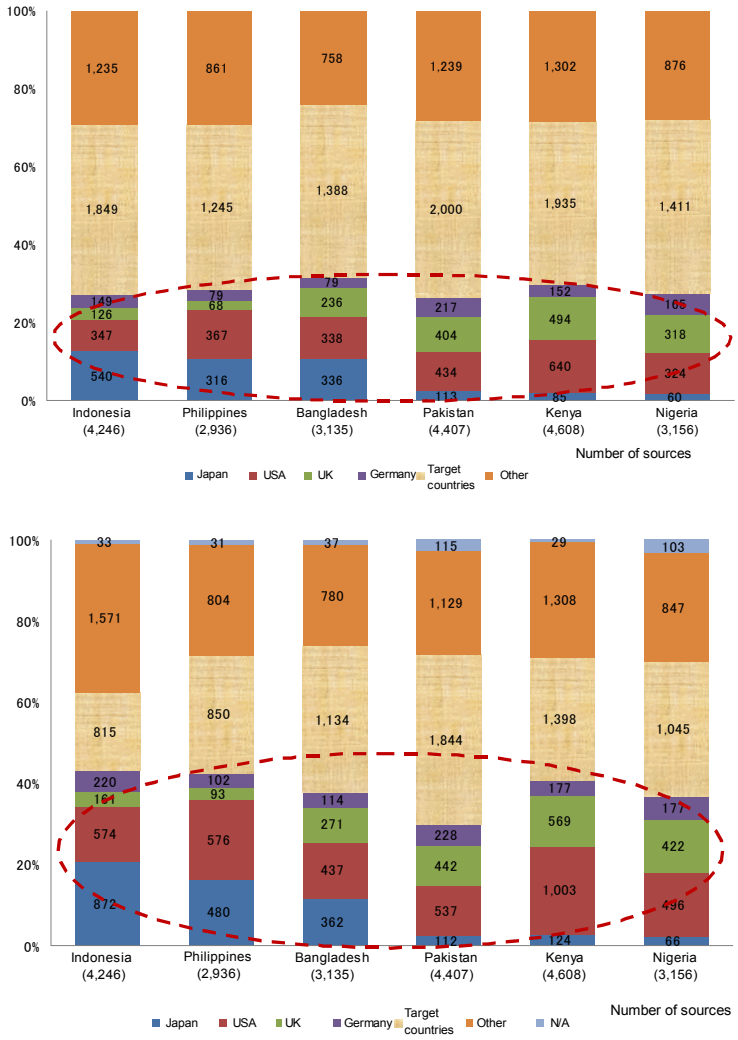
Table/Chart 43 shows a breakdown of key coauthor countries (Japan, U.S., U.K., and Germany) to the six target countries and their ownership rates at international coauthorship[17]. The total ownership percentage of these coauthors countries (38.5% on average) is relatively higher than their total share of international coauthorship (28.5% on average); thus, they are assumed to play a leading role often in publishing international joint papers. For the U.S., the ownership rate is higher than the share of international coauthorship in all six countries. With regard to Japan, the same trend can be identified with two Southeast Asian countries. This suggests that Japan often assumes leadership in research activities in those two countries.

The number of sources owned as a percentage of international joint papers in major countries of origin is shown in Table/Chart 44. The table indicates that six target countries have a lower ownership rate than their major coauthor nations with regard to international joint papers. Among the target nations, Indonesia is the lowest at 44.1%, while Pakistan shows the highest rate at 92.2%. The U.S. constantly shows a high ownership rate except in Bangladesh among the major four countries, while Japan accounts for the highest share in Indonesia among six countries.

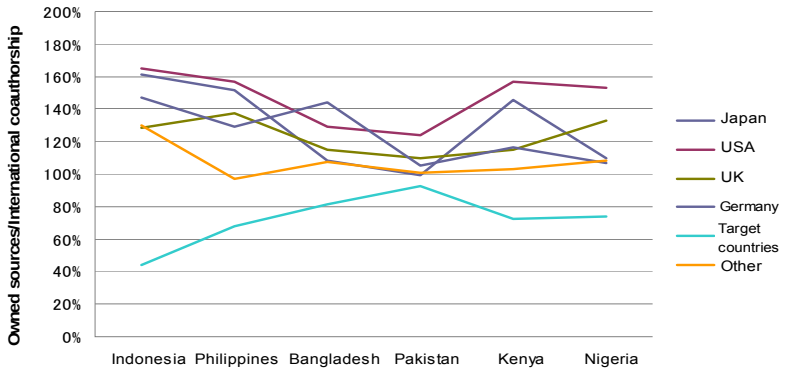
It can be assumed that the fewer the number of coauthor countries engaged in international joint writing with a country is, the more likely a country has the ownership of the papers (although it is different depending on a country combination). Therefore, most of joint papers with the U.S. and Japan (only in the two Southeast Asian countries) may be bilateral coauthorship. In the meantime, Japan shows a high bilateral coauthorship rate with these two Southeast Asian countries, while the rate of coauthorship with more than three countries is high in the U.S. (see Table/Chart 49 and Table/Chart 50). As a result, it is assumed that the U.S. plays a leading role in academic publishing (or have a responsibility for the content of sources) regardless of the number of coauthor countries. On the other hand, Japan tends to have many joint papers (bilateral coauthorship) especially with two Southeast Asian countries.

[17] The breakdown of international coauthorship was calculated based on fractional counting for comparison with ownership and showed smaller figures than actual numbers.

Table/Chart 43　Comparison of the country breakdown of international coauthorship and that of ownership (Above: International coauthorship, Below: Ownership)




Table/Chart 44　Number of sources owned as a percentage of international joint papers



### 4.4.2 Selection of international coauthors and the backgrounds

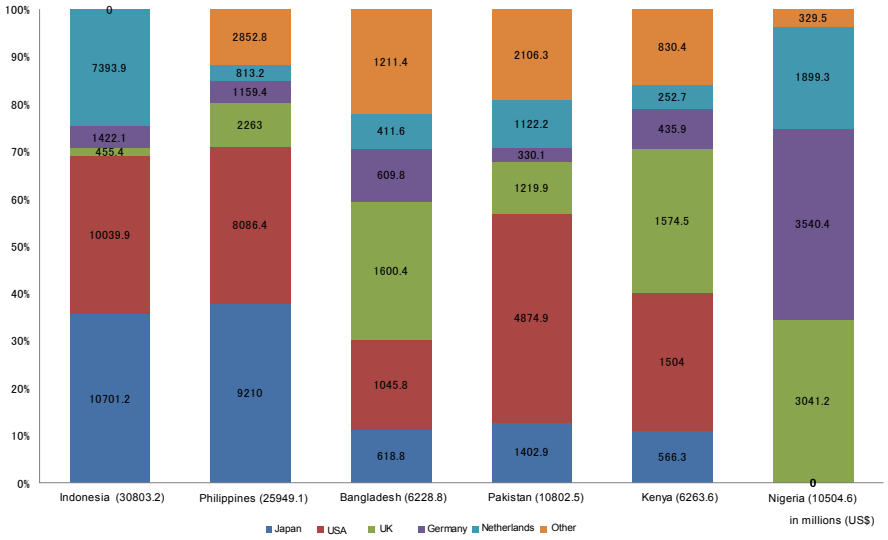
In order to study the financial relationship between the target countries and their major coauthor countries, we analyzed total fund flows between the six target countries and the donors of OECD Development Assistance Committee (DAC) for the 10-year period from 1998 to 2007. Table/Chart 45 shows the breakdown these fund flows by these major coauthor countries. There are some points that should be noted; for example, the funds from Japan and the U.S. to Nigeria show negative values even if a 10-year fund flow is accumulated. However, the total share of Japan, the U.S., the U.K., and Germany is as high as 70−85% in every target country. Especially, the U.S. has a large share in each of the target nations except Nigeria. Indeed, regional characteristics can be confirmed here. Japan competes with the U.S. as the largest source of funds for Indonesia (35.7%) and the Philippines (37.8%). In the meantime, the U.K. has a larger share in three countries (30−35%), which consists of two African nations and Bangladesh, than in two Southeast Asian countries (below 10%). These trends are considered to be similar to source-ownership or a breakdown of coauthors.

Overseas students may have influence on connections of international coauthorship among researchers. Especially, students who have received a doctoral degree are likely to publish joint papers with their academic supervisors (i.e., advisors concerning their dissertation) for a while if they continue research activities after returning to their home countries. We study the relation between coauthor countries and the actual number of overseas students. Table/Chart 46 shows the number of students of the target countries who studied at overseas higher education institutes (actual figures in 2005) for each recipient country. The table/chart mainly indicates the number of students in higher education (ISCED97 level 5 & level 6), which covers every category (field) including humanities and social sciences.

The U.S. accounts for a large share in these six countries in common, while the U.K. has a sizable proportion in three countries including two African nations and Pakistan. Australia shows a high percentage concerning acceptance of students from five countries excluding Nigeria. For Japan, a relatively large proportion can be seen in two Southeast Asian countries (4.2% and 7.3% each) as well as in Bangladesh (6.3%), buts its share in the other three nations (2 African nations and Pakistan) is less than 1%.

This indicates a relation between the fund flow and coauthor countries. Among the flow, a fund related to ODA (Official Development Assistance) is included; thus, it is assumed that the academic exchange between researchers in developing countries and those in advanced countries starts as part of academic assistance and then leads to international coauthorship. Correlation between overseas students and academic publishing can be seen in the U.S. and U.K. In the meantime, Japan has a large share of international coauthorship in two Southeast Asian countries (17.9% and 14.0% each), yet acceptance of students from these nations is small. For Malaysia, coauthorship with Indonesia is small (1.9%) but acceptance of students from the country is high (19.2%). Therefore, it is difficult to analogize a direct relation between academic papers and overseas students from this result. Nonetheless, it may be required to conduct re-analysis based on appropriate data concerning international students (students who have a doctoral degree and study abroad in Natural Science fields) because the data used in this survey include undergraduate students and fields are not limited to Natural Science.

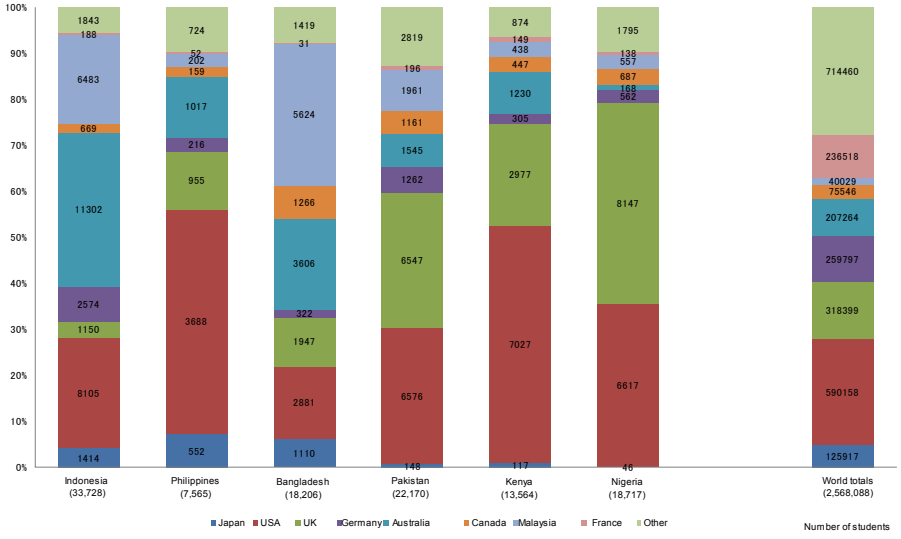
Table/Chart 45　Fund flow between target countries and major coauthor countries (10-year accumulation)




Source: Compiled based on OECD International Development Statistics

Note: The data is an accumulation between 1998 and 2007 and includes real ODA, real OOF and private investments. Although it is based on 10-year accumulation, negative figures are included probably because of debt relief. Negative values in the graph are treated as 0 (zero) for convenience. Each country receives funds from multilateral donor institutions as well, but the data refers only to bilateral funds. Target fields are not considered. For instance, even if we limit the target to the educational field, it is not clear if funds are directly related to research in science and technology in university as elementary and secondary education was mainly supported during the period. Therefore, we focus on a comprehensive trend.

Table/Chart 46　Key countries receiving international students from target countries (FY 2005)



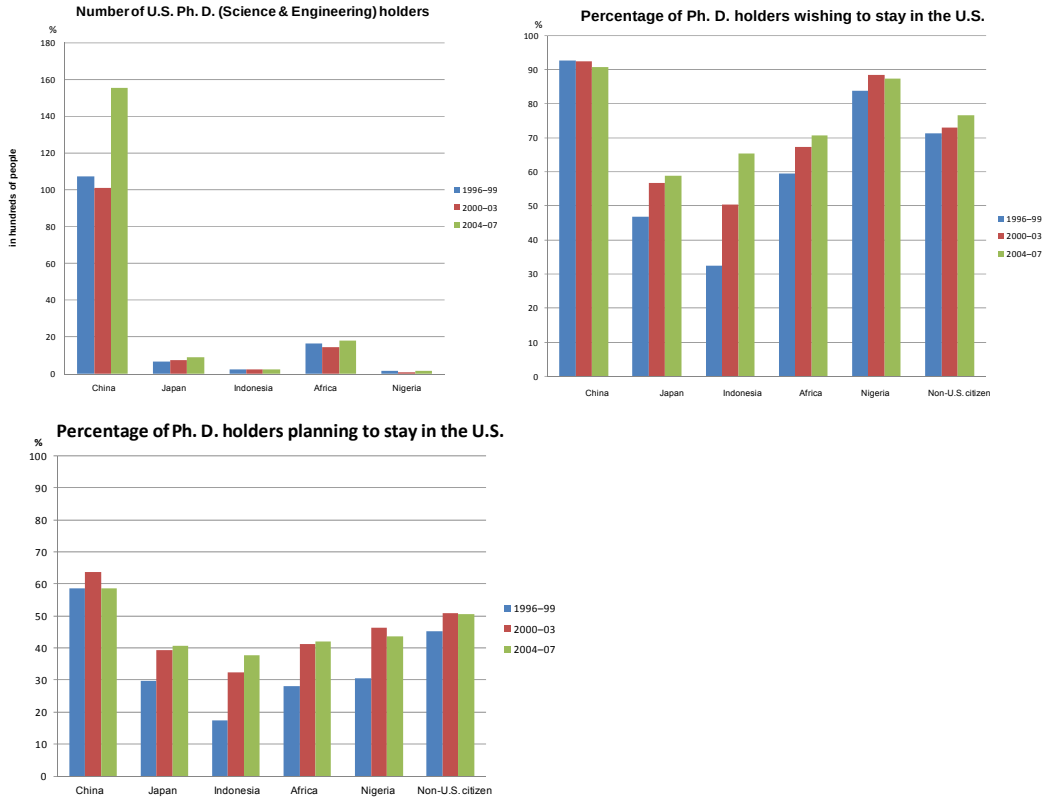

Source: Compiled based on “International flows of mobile students at the tertiary level (ISCED 5 and 6)” UIS

(Reference) International students who have obtained a natural science doctoral degree in Japan and the U.S. and their return to home countries

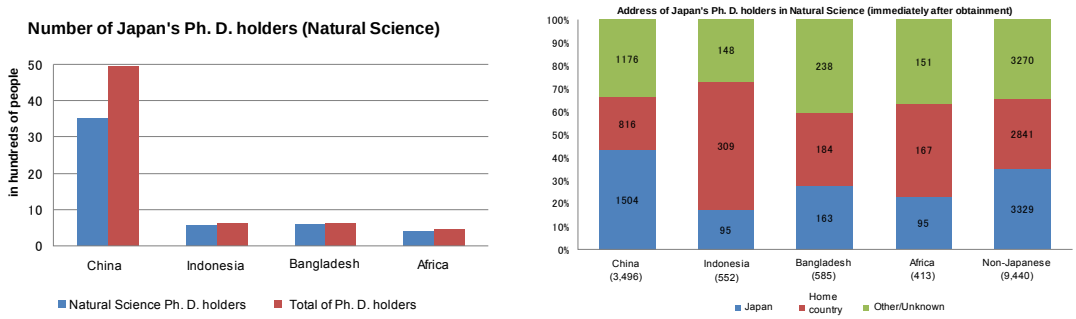
Table/Chart 47 shows the percentage of foreign citizens who have obtained a doctoral degree in Natural Science in Japan or the U.S. and choose to stay in recipient countries. For the U.S., the number of Chinese doctoral degree holders is larger than that of doctoral degree holders with other nationalities, and most of them wish to stay in the U.S. The percentage of Indonesian students who plan or wish to stay in the U.S. has grown recently. There are many Chinese doctoral degree holders in Japan as well, and they show a relatively high percentage of stay among the overall non-Japanese students (considered as foreign students). In the meantime, a greater percentage of Indonesian students in Japan return to their home country compared with the other overseas students.

It is not simple to compare international students who have obtained a doctoral degree in Japan and stay there and their counterparts in the U.S. due to the difference in the target period and subject category classification. However, the available data at least show that the percentage of stay in Japan (35.3%) is lower than the U.S. (50.7%). A low rate of stay in recipient countries may be related to the latest increase of international coauthorship with academic supervisors when the students return to their home countries. Conversely, if a percentage of stay in recipient countries is high, the researchers who remain in the recipient nations might become a hub of a future network (e.g., becoming a partner of researchers who remain in home countries when they conduct international join research).

Table/Chart 47 Comparison between Japan and the U.S. concerning the return to the home country of Natural Science Doctors with foreign nationalities (Above: U.S., Below: Japan)




Source: NSF 2005 “National Science Indicators 2006”



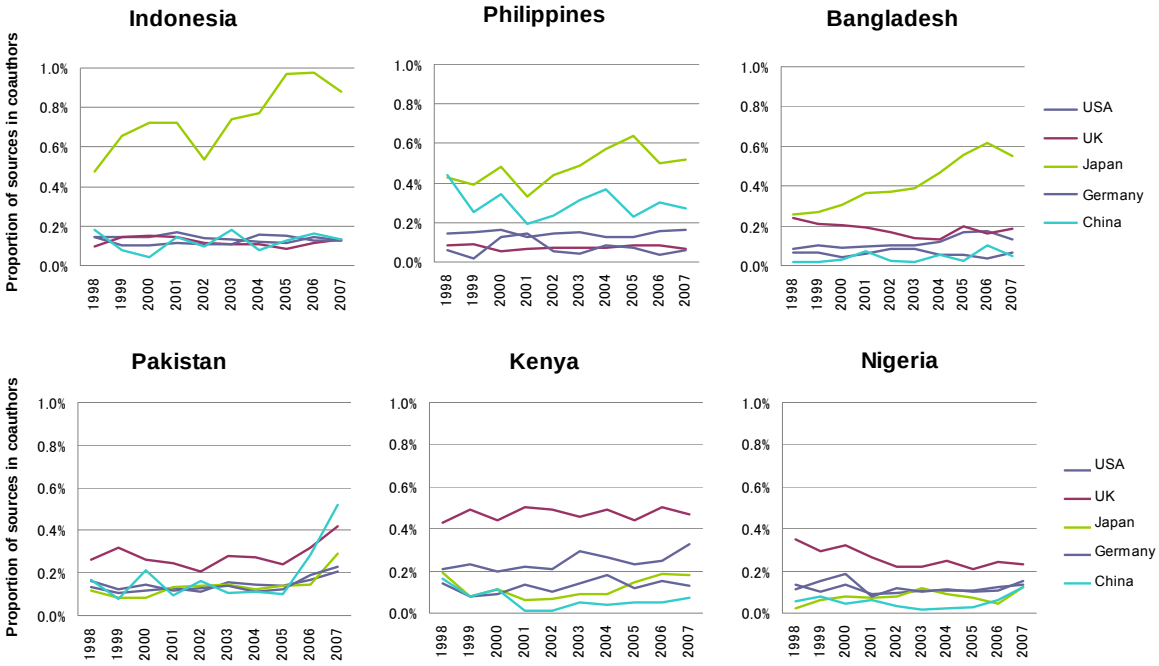

Note: Based on the accumulation of doctoral degree holders in Japan between FY 2002 and FY 2006.

Source: Compiled based on 2009 NISTEP REPORT 126 “Survey on a career path of doctoral degree holders in Japan,” National Institute of Science and Technology Policy

### 4.4.3 Academic publishing of target countries in their major coauthor countries

Table/Chart 48 shows movements in the share of joint papers published with the target six countries in five countries, namely, four main coauthor countries (U.S., Japan, U.K., and Germany) and rapidly emerging China. First, it can be identified that the share of every target country is as small as less than 1%. For Indonesia, the Philippines, and Bangladesh, the share of coauthorship in Japan is higher than that of coauthorship in the other major coauthor countries (U.S., U.K., Germany, and China), and that the share has increased in general, although a temporary drop or slump can be observed. Pakistan, Kenya, and Nigeria tend to have a higher percentage of coauthorship with the U.K. than with the other countries. However, in the U.K., the share of Kenya is sluggish and that of Nigeria is declining. Pakistan’s share of coauthorship in China has been on increase since 2005.

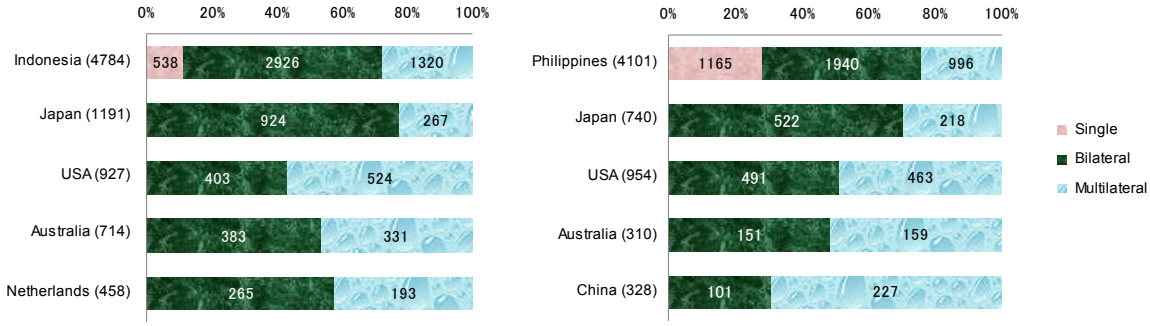
Table/Chart 48 Movements in the share of joint papers with target countries in major international coauthor countries



### 4.4.4 International coauthorship between Japan and target countries

We analyze the characteristics of international coauthorship between Japan and target nations focusing on the difference in the number of coauthor countries. Table/Chart 49 shows a breakdown of coauthorship by the number of coauthor countries for the top five coauthors for Indonesia and the Philippines. For Japan, Indonesia, and the Philippines, the number of multilateral joint papers is small here. This suggests that multilateral coauthorship accounts for a large share of Indonesian academic papers published with the U.S. and Philippines papers published with China.

Table/Chart 49 Breakdown of international coauthorship by the number of coauthor countries (top 5) (Left: Indonesia, Right: Philippines)



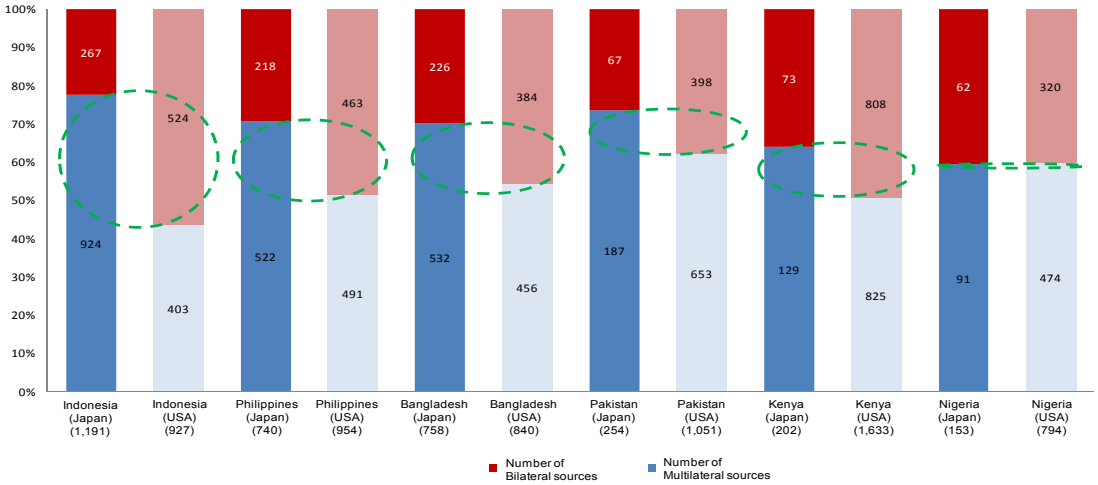

Table/Chart 50 indicates bilateral and multilateral coauthorship of Japan and the U.S. in six target countries. The reason for selecting the U.S. is that the country shows as low an international coauthorship rate as Japan (24.8% and 20.5%, respectively), while Europe has a high percentage in general. We compared the characteristics of coauthorship between Japan and the target countries with those of coauthorship between the U.S. and those countries. It was found that in Southeast Asian and other countries that are geographically close to Japan, the degree by which the bilateral coauthorship rate is higher than the multilateral coauthorship rate in Japan is greater than that in the U.S. For countries far from Japan, including two South Asian countries and two African nations, the gap between Japan and the U.S. is narrower.

With regard to multilateral coauthorship, Table/Chart 51shows a list of countries (top 10 in the number of joint papers) with which Japan and the U.S. engage in joint writing (excluding the target developing countries) and combinations of coauthor countries in multilateral coauthorship in Japan and the U.S. are listed in Table/Chart 52. In multilateral coauthorship, the difference between Japan and the U.S. concerning the selection of the third (or more) nation besides the target country can be seen from the number of high-income OECD countries. As shown in Indonesia's data in Table/Chart 51 for example, the U.S. includes a greater number of high-income OECD nations as the third partner than Japan does (six countries, compared with three for Japan). However, both Japan and the U.S. indicate that joint publishing with high-income OECD countries account for a large portion in coauthorship with two African countries. A similar trend can be confirmed in Table/Chart 52, which shows combinations of coauthors. Behind these situations, there seem to be a cultural affinity including language, which makes it easier for Western countries to conduct joint research with others in the West that have a high capability of academic publishing.

Table/Chart 53 shows the top five subject categories of multilateral joint papers in Japan and the U.S. Clinical Medicine is commonly included in both countries as a field of multilateral coauthorship. For the U.S., the field has the largest number of papers among the other categories and its percentage is higher than that in Japan.

The difference in the share of bilateral and multilateral sources between Japan and the U.S. may be attributed to international researchers' networks based in the U.S. (e.g., network between the U.S. researchers and citizens or those who returned to their home counties after studying in the U.S. [i.e., have the current address outside the U.S.] and researchers living in the U.S. [i.e., have the current address in the U.S.]). In the meantime, Table/Chart 49 shows that China tends to engage in multilateral coauthorship rather than bilateral joint writing. China may have a reason different from that of the U.S. for its multilateral coauthorship. In addition to writing with researchers outside China, Chinese researchers, who often go abroad, may be engaged in coauthorship, for example, with Chinese spread across the world or through a Chinese network.

Table/Chart 50　Breakdown of international coauthorship by the number of coauthor countries (comparison between Japan and U.S.)




Table/Chart 51　List of multilateral coauthors for Japan and the U.S. (Above: Japan, Below: U.S.)

| Indonesia | | Philippines | | Bangladesh | | Pakistan | | Kenya | | Nigeria | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Sources | Country | Sources | Country | Sources | Country | Sources | Country | Sources | Country | Sources |
| United States | 79 | United States | 93 | India | 57 | United States | 17 | United States | 42 | United States | 31 |
| Korea, Rep. | 41 | China | 64 | United States | 57 | China | 14 | United Kingdom | 17 | China | 20 |
| Thailand | 39 | India | 39 | United Kingdom | 22 | India | 10 | Germany | 16 | France | 17 |
| China | 32 | Korea, Rep. | 35 | Germany | 21 | Germany | 8 | China | 9 | Italy | 17 |
| Australia | 29 | Australia | 32 | China | 19 | Korea, Rep. | 8 | Australia | 7 | Germany | 15 |
| Malaysia | 27 | Thailand | 32 | Thailand | 16 | United Kingdom | 8 | Netherlands | 7 | Spain | 15 |
| India | 25 | France | 23 | Spain | 11 | Bangladesh, Canada, Indonesia, Philippines, Sweden, Taiwan | 5 | France | 6 | Belgium | 14 |
| United Kingdom | 22 | United Kingdom | 23 | Australia | 10 | | | | | Mexico | 14 |
| Philippines | 18 | Malaysia | 22 | Korea, Rep. | 10 | | | | | Netherlands | 14 |
| Brazil | 16 | Singapore | 21 | Indonesia | 6 | | | | | Lebanon | 13 |

| Indonesia | | Philippines | | Bangladesh | | Pakistan | | Kenya | | Nigeria | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Sources | Country | Sources | Country | Sources | Country | Sources | Country | Sources | Country | Sources |
| Australia | 92 | China | 110 | United Kingdom | 98 | United Kingdom | 104 | United Kingdom | 300 | United Kingdom | 82 |
| Japan | 79 | Japan | 93 | India | 64 | Germany | 65 | Netherlands | 101 | Germany | 43 |
| United Kingdom | 69 | India | 68 | Japan | 57 | India | 57 | Switzerland | 92 | France | 35 |
| Thailand | 60 | Australia | 66 | Switzerland | 43 | Canada | 47 | South Africa | 81 | South Africa | 34 |
| Germany | 57 | Thailand | 66 | Sweden | 41 | China | 45 | Canada | 75 | Switzerland | 33 |
| Netherlands | 55 | United Kingdom | 57 | Korea, Rep. | 24 | Italy | 42 | France | 63 | Japan | 31 |
| China | 49 | France | 52 | France | 20 | Switzerland | 27 | Germany | 57 | Netherlands | 31 |
| France | 45 | Singapore | 48 | China | 19 | France | 24 | Australia | 48 | China | 30 |
| India | 42 | Canada | 46 | Thailand | 19 | Korea, Rep. | 24 | Belgium | 42 | Belgium | 29 |
| Vietnam | 40 | Germany | 42 | Canada | 18 | South Africa | 22 | Japan | 42 | Italy | 26 |

Note: High-income OECD nations are highlighted

Table/Chart 52 Combinations of coauthors for Japan and the U.S. in multilateral publishing (Top 10)

| Indonesia | | | Philippines | | | Bangladesh | | | Pakistan | | | Kenya | | | Nigeria | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ranking | Country pair | Sources | Ranking | Country pair | Sources | Ranking | Country pair | Sources | Ranking | Country pair | Sources | Ranking | Country pair | Sources | Ranking | Country pair | Sources |
| 11 | Australia, United States | 42 | 11 | Japan, United States | 33 | 11 | United Kingdom, United States | 46 | 16 | United Kingdom, United States | 46 | 7 | United Kingdom, United States | 128 | 12 | United Kingdom, United States | 39 |
| 13 | Japan, United States | 41 | 14 | China, United States | 29 | 13 | Japan, United States | 40 | 20 | Germany, United States | 30 | 13 | Netherlands, United States | 49 | 24 | Germany, United States | 16 |
| 14 | Australia, Italy | 37 | 17 | India, United States | 21 | 15 | India, Japan | 35 | 30 | Canada, United States | 15 | 19 | Canada, United States | 31 | 31 | Ghana, United States | 12 |
| 18 | Netherlands, United States | 24 | 19 | Germany, United States | 19 | 18 | India, United States | 24 | 36 | India, United States | 12 | 23 | Uganda, United Kingdom | 29 | 32 | South Africa, United States | 12 |
| 20 | Japan, Thailand | 22 | 22 | Australia, United States | 16 | 23 | Germany, Japan | 17 | 38 | Japan, United States | 11 | 24 | Japan, United States | 27 | 34 | Belgium, United States | 10 |
| 21 | Japan, Korea, Rep. | 20 | 27 | Canada, United States | 12 | 25 | Netherlands, United Kingdom | 17 | 40 | China, United States | 11 | 29 | South Africa, United Kingdom | 22 | 36 | Belgium, United Kingdom | 9 |
| 22 | Germany, United States | 20 | 29 | Thailand, United States | 12 | 28 | Germany, Sweden | 15 | 41 | Germany, United Kingdom | 10 | 30 | Switzerland, United States | 22 | 37 | Cameroon, United Kingdom | 9 |
| 24 | Canada, United States | 18 | 30 | United Kingdom, United States | 12 | 29 | India, United Kingdom | 15 | 43 | Malaysia, Thailand | 10 | 31 | Canada,United Kingdom | 21 | 38 | Cameroon, United States | 9 |
| 25 | Thailand, United States | 18 | 34 | France, United States | 10 | 30 | Sweden, United States | 15 | 45 | Saudi Arabia, South Africa | 10 | 32 | Netherlands, United Kingdom | 20 | 39 | Germany, United Kingdom | 9 |
| 27 | Australia, United Kingdom | 16 | 35 | Germany, India | 10 | 31 | Switzerland, United States | 15 | 52 | Brazil, Germany | 8 | 33 | South Africa, United States | 20 | 40 | Jamaica, United States | 9 |
| | | | | | | | | | 53 | Italy, Saudi Arabia | 8 | | | | | | |
| | | | | | | | | | 54 | Japan, China | 8 | | | | | | |

Note: Japan and U.S. are omitted. Bilateral papers are excluded.

Table/Chart 53 Subject categories of papers for Japan and the U.S. in multilateral publishing (Above: Japan, Below: U.S.)

| Indonesia | | Philippines | | Bangladesh | | Pakistan | | Kenya | | Nigeria | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | Sources | Category | Sources | Category | Sources | Category | Sources | Category | Sources | Category | Sources |
| Clinical Medicine | 51 | Clinical Medicine | 45 | Clinical Medicine | 40 | Physics | 13 | Plant & Animal Science | 22 | Plant & Animal Science | 13 |
| Plant & Animal Science | 47 | Plant & Animal Science | 38 | Microbiology | 33 | Plant & Animal Science | 9 | Clinical Medicine | 14 | Agricultural Sciences | 8 |
| Geosciences | 33 | Environment/Ecology | 26 | Chemistry | 27 | Clinical Medicine | 7 | Microbiology | 7 | Clinical Medicine | 7 |
| Physics | 22 | Geosciences | 18 | Plant & Animal Science | 25 | Chemistry | 6 | Agricultural Sciences | 6 | Psychiatry/Psychology | 7 |
| Environment/Ecology | 17 | Agricultural Sciences | 13 | Physics | 19 | Engineering | 4 | Environment/Ecology | 5 | Chemistry | 5 |

| Indonesia | | Philippines | | Bangladesh | | Pakistan | | Kenya | | Nigeria | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Category | Sources | Category | Sources | Category | Sources | Category | Sources | Category | Sources | Category | Sources |
| Clinical Medicine | 147 | Clinical Medicine | 119 | Clinical Medicine | 141 | Clinical Medicine | 108 | Clinical Medicine | 272 | Clinical Medicine | 108 |
| Plant & Animal Science | 60 | Plant & Animal Science | 86 | Chemistry | 56 | Physics | 58 | Plant & Animal Science | 144 | Agricultural Sciences | 37 |
| Geosciences | 59 | Agricultural Sciences | 49 | Environment/Ecology | 26 | Molecular Biology & Genetics | 49 | Immunology | 88 | Plant & Animal Science | 30 |
| Environment/Ecology | 50 | Environment/Ecology | 37 | Microbiology | 26 | Geosciences | 23 | Environment/Ecology | 81 | Environment/Ecology | 20 |
| Agricultural Sciences | 29 | Immunology | 24 | Immunology | 23 | Engineering | 22 | Microbiology | 41 | Biology & Biochemistry | 19 |

## 4.5 Academic background of the 30 most productive researchers

We attempted to select the 30 most productive researchers of the six target countries according to the number of sources, based on the WoS data between 1998 and 2008. For Pakistan and Bangladesh, it was determined that identifying individual researchers by the name (family name and initials) in the database was difficult. Therefore, we focused on four countries: the Philippines, Indonesia, Kenya, and Nigeria[18].

We attempted to obtain the academic background information of a total of 120 researchers in those four countries from data available on the Web. Information regarding Philippine researchers was disclosed at a higher ratio, the country of doctoral degree was found for 28 among 30 researchers. On the other hand, for Kenya, the equivalent information was identified

[18] In Pakistan, a researcher with the largest number of sources between 1998 and 2008 published 390 papers, followed by another researcher who published 325 papers; while a top researcher delivered 200 sources, followed by a second researcher who published 158 papers in Bangladesh. Fields of sources of the top researcher in Pakistan were Chemistry, Medicinal (197) and Plant Sciences (76), while those of the second researcher included Crystallography (105), Engineering and Chemical (26). We are not necessarily able to define that the same person conducted these works, yet we have concluded that there is a high possibility that the researcher is not the same person considering the fact that the number of sources is obviously larger than top researchers in the other 4 countries (149 in Kenya and some 60 in the other countries).

only for 11 researchers. This indicates that access to information is imbalanced depending on country.

Table/Chart 54 shows the results of investigation concerning the locations (countries) of institutions to which researchers belong. It shows that the own country assumes a dominant position in four countries in common. For the Philippines and Nigeria, the countries themselves account for more than 80%, while Indonesia and Kenya shows less than 50%.

Table/Chart 55 shows the names of countries in which researchers obtained a bachelor's degree[19]. A majority of researchers attained their bachelor's degrees at university in their own countries, while many doctoral degrees were obtained in advanced nations. This trend is commonly identified in three countries excluding Nigeria. The U.S. accounts for a large part of the countries where doctoral degrees were obtained in the target countries except Indonesia. In the meantime, geographical closeness and historical relations seem to have some influence: In Indonesia, some researchers got a doctoral degree in Australia and Japan, both of which are geographically close to the country, while in the Philippines many researchers obtained a doctoral degree in the U.S. or in Japan.

It is not easy to specify the nationality of those 120 researchers from disclosed information. However, with regard to Indonesia, if we assume that an institution they currently belong to is located within the country and that researchers who obtained a bachelor's degree in the country are Indonesian nationals, seven such researchers can be identified. Among them, two researchers obtained a doctoral degree in Indonesia and others were given a doctoral degree in the U.S., Australia, or elsewhere.

Table/Chart 54 Home countries of affiliated institutions of the 30 most productive researchers

| Indonesia | | Philippines | | Nigeria | | Kenya | |
|---|---|---|---|---|---|---|---|
| Address of Institutions | Number of institutions | Address of Institutions | Number of institutions | Address of Institutions | Number of institutions | Address of Institutions | Number of institutions |
| Indonesia | 11 | Philippines | 25 | Nigeria | 26 | Kenya | 15 |
| Japan | 7 | Japan | 3 | United States | 4 | United States | 10 |
| United States | 5 | United States | 2 | | | United Kingdom | 5 |
| Australia | 5 | | | | | | |
| Italy | 1 | | | | | | |
| South East Asia | 1 | | | | | | |
| Total | 30 | Total | 30 | Total | 30 | Total | 30 |

Table/Chart 55 Countries of degree for the 30 most productive researchers
(Above: Bachelor, Below: Doctoral degree)

| Country of Bachelor degree | Number of holders | Country of Bachelor degree | Number of holders | Country of Bachelor degree | Number of holders | Country of Bachelor degree | Number of holders |
|---|---|---|---|---|---|---|---|
| Indonesia | 5 | Philippines | 8 | Nigeria | 10 | Kenya | 3 |
| Japan | 2 | India | 4 | United States | 2 | United States | 2 |
| Australia | 1 | China | 2 | Congo | 1 | Australia | 2 |
| United Kingdom | 1 | Japan | 2 | Sierra Leone | 1 | Germany | 1 |
| Malaysia | 1 | Australia | 2 | | | | |
| New Zealand | 1 | Canada | 1 | | | | |
| | | India | 1 | | | | |
| | | United States | 1 | | | | |
| | | Netherlands | 1 | | | | |
| Total | 11 | Total | 22 | Total | 14 | Total | 8 |

[19] We have data concerning the country where a master's degree was obtained, but we will omit analysis on the master's course as the amount of data is smaller than that of doctoral degree. For the U.S. and U.K., students in a research course of Natural Science sometimes go into a doctoral degree course, bypassing the master's course and without obtaining a master's degree.

| Indonesia | | Philippines | | Nigeria | | Kenya | |
|---|---|---|---|---|---|---|---|
| Country of Ph. D. | Number of holders | Country of Ph. D. | Number of holders | Country of Ph. D. | Number of holders | Country of Ph. D. | Number of holders |
| Australia | 3 | United States | 8 | Nigeria | 10 | Kenya | 3 |
| Germany | 3 | Philippines | 6 | United States | 4 | United States | 2 |
| Indonesia | 2 | Japan | 5 | United Kingdom | 1 | United Kingdom | 2 |
| Netherlands | 2 | India | 4 | Australia | 1 | Canada | 1 |
| Japan | 2 | Australia | 2 | Congo | 1 | Switzerland | 1 |
| United States | 1 | Germany | 2 | | | Belgium | 1 |
| United Kingdom | 1 | Netherlands | 1 | | | South Africa | 1 |
| New Zealand | 1 | | | | | | |
| China | 1 | | | | | | |
| Total | 16 | Total | 28 | Total | 17 | Total | 11 |

# 5. Research activities in developing countries (Interview surveys in two countries)

In this chapter, we focus on two Southeast Asian countries (Philippines and Indonesia) as targets, considering geographical closeness and the size of academic support from Japan. We conducted interview surveys concerning researchers who belong to institutions located in these two countries and published a substantial number of papers in international academic journals. This chapter analyzes the findings from these interviews with attention to their research activities.

In the previous chapter (Chapter 4), we analyzed the academic publishing of six countries between 1998 and 2008 as a case study. We found that both the Philippines and Indonesia have a high international coauthorship rate and produced many joint papers with Japan and the U.S. Questions asked in the interviews refer to the following topics in the two countries: Incentives to publish papers, advantages of international coauthorship, treatment of researchers, and education for researchers. Furthermore, we will organize comments from related parties concerning Japan's academic support to those countries including current problems and improvement in the future.

## 5.1 Interview summary

The interview consists of domestic (preliminary) and overseas (main) surveys. Each of them is summarized as follows:

### (1) Domestic survey

Objective:

Objective is to understand the reality of coauthorship and perception of research activities in the Philippines and Indonesia by interviewing Japanese researchers who have published many joint papers with researchers who belong to institutions in the Philippines or Indonesia.

Period: August–September 2009

Selection of interviewees:

We selected four Japanese researchers who have published joint papers with researchers who belong to institutes located in the Philippines or Indonesia, based on the WoS data. One researcher introduced by an interviewee was added; thus, the actual interviewees were five professors, two assistant professors, and one project leader, including people who attended the interview. The topics of the interview and list of interviewees are shown in Table/Chart 56 and Table/Chart 57, respectively.

Table/Chart 56 Topics of the interview in the domestic survey

| | Survey Items |
|---|---|
| 1 | Reasons for having academic exchange with Philippines and Indonesia |
| 2 | Forms of international coauthorship |
| 3 | Incentives to researchers in academic publishing in two countries |
| 4 | Challenges of research activities in two countries such as research environment and education for graduate students |
| 5 | Japan's academic support for two countries |

Table/Chart 57　List of interviewees

| Number | Interview contents | Targets |
|---|---|---|
| ① | Status of research environment and academic publishing | Researchers who publish amount of academic articles in international journal |
| ② | Development of faculty and researchers | Dean of department of science and engineering in major universities |
| ③ | Japan's supports to research activities and education for highly skilled workers | Japanese Embassy, JICA, Japanese experts |
| ④ | Measures of improvement for higher education and science and technology | Government officials |

(2)　Overseas survey (Philippines and Indonesia)

Objective:

Objective is to understand (1) the research environment of researchers who stay in the Philippines or Indonesia and have published many papers in international academic journals; (2) education for researchers in these countries; and (3) the reality of Japan's academic supports and its challenges.

Period: October 6-17, 2009

Selection of interviewees:

We interviewed researchers and government officials focusing on the research environment and education for researchers. First, we interviewed researchers belonged to higher-education/research institutions representing the countries and presenting many papers in international journals in order to understand their research environment and development of researchers in their countries. We also interviewed the Dean of the Engineering Department of a leading higher educational institute in the target countries in order to understand the education for researchers. This Department of Engineering takes part in the project (AUN/SEED-Net[20]) in which Japan provides support for higher education in the field of Engineering in ASEAN. Furthermore, we interviewed officials of related ministries to understand the status of measures concerning research functions in higher education and the promotion of science and technology in those countries. We also included the officials of Japanese embassy and JICA staff in both countries so as to understand the reality and challenges of support provided by Japan to foreign students. Table/Chart 58 shows the interview contents and targets of the interview. Positions and institutions of the interviewees are indicated in Table/Chart 59.

[20] Launched by JICA for the purpose of developing human resource in the field of engineering at higher education in cooperation with 19 universities in ten nations joining in ASEAN and 11 Japanese universities. A five-year technical assistance project was launched in May 2003 in order to "improve ability of education/research of the member universities," followed by Phase 2 having started in May 2008. http://www.seed-net.org/01_index_jp.php

Table/Chart 58　Overseas survey topics and interviewees

| No. | Items | Targets |
|---|---|---|
| ① | Status of research environment and academic publishing | Researchers who have many sources |
| ② | Development of faculty and researchers | Dean of department of science and engineering in major universities |
| ③ | Japan's supports to research activities and development of special researchers | Japanese Embassy, JICA, Japanese experts and others |
| ④ | Measures concerning promotion of high education and science and technology | Government staff of both countries |

Table/Chart 59　Overseas survey interviewees and their institutions

| Country | Category | Institution | Post of Interviewee | City |
|---|---|---|---|---|
| Philippines | ① | Physics , College of Science, National Institute of Physics, University of the Philippines | Dean & Professor | Manila |
| | | Chemical Engineering Department, De La Salle University | Professor | |
| | | Marine Science Institute, University of the Philippines | Professor | |
| | ② | Chemical Engineering Department, College of Engineering, De La Salle University | Dean & Professor | |
| | | College of Engineering, University of the Philippines | Dean & Professor<br>Associate Dean for Academic Affairs | |
| | ③ | Japanese Embassy in the Philippines | Minister<br>First Secretary<br>Researcher/Advisor | |
| | | JICA office in the Philippines | Staff<br>Program Officer, Training Program Section | |
| | | International Rice Research Institute | Plant Breeder, Plant breeding, Genetics, and Biotechnology | Los Banos |
| | ④ | Commission on the Higher Education, Office of the President | Director IV, Office of Planning, Research & Special Project | Manila |
| | | Commission on the Higher Education, Office of the President | Secretary/Chairman<br>Director IV, Office of Planning, Research & Special Project<br>Director IV, Office of Programs and Standards | |
| | - | Training Center, International Rice Research Institute | Jr.Associate Scientists/Agric. Engineer | Los Banos |
| Indonesia | ① | Department of Physics, Faculty of Mathematics and Natural Sciences, University of Indonesia | Research Coordinator | Jakarta |
| | | Maju Makmur Mandiri Research Center | Director | |
| | | Department of Chemistry, Faculty of Mathematics and Natural Science、Gadjah Mada University | Head of Chemistry Department<br>Professor<br>Vice Dean of Research and Cooperation Affair & Professor | Jogyakarta |
| | | Faculty of Mathematics and Natural Science, Institute Technology Bandung | Professor | Bandung |
| | | Departmenet of Physics, Faculty of Mathematics and Natural Science, Institute Technology Bandung | Former Professor<br>Associate Professor<br>Assistant Professor | |
| | | Plant Resources of Souht-East Asia Association(PROSEA), Indonesian Institute of Science | Professor | Cibinong |
| | ② | Department of Geological Engineering, Gadjah Mada University | Head | Jogyakarta |
| | ③ | Japanese Embassy in Indonesia | First secretary | Jakarta |
| | | Ministry of National Educaiton | Advisor to DGHE(Director General of Higher Education) (JICA Expert) | |
| | ③④ | Ministry of Research and Technology (RISTEK), LIPI | Advisor to the Minister for Research and Technology （JICA Expert）<br>Assistant Deputy for National Research Science and Technology Program<br>Director, Indonesian Institute of Science, Center for Science and Technology Development Studies<br>Head of Division, Indicators of S&T National | |

Note:　Category Number is corresponding to Table/Chart 58.

## 5.2 Characteristics of the target countries (Philippines and Indonesia) in the overseas survey

With regard to higher education and research activities in the Philippines and Indonesia, this section describes the outlines of the scale of higher education and academic background of faculty members; history of development of higher education; related measures; and movements in the number of students majoring in natural sciences at graduate schools in Japan. Both countries show that they have many private higher-education institutes and that the number of students studying natural science and faculty members with doctoral degrees is scarce there. Behind the mismatch of the supply and demand of human resources among fields (e.g., students majoring in natural sciences are scarce), it is pointed out that private sectors have provided low-cost education to meet increased demands for higher education. The salary of faculty has been set at a low level to realize low-cost education. This indicates that conditions for research activities may not be sufficient in these countries.

### 5.2.1 Higher education in the Philippines and Indonesia

Table/Chart 60 shows the number of higher education institutes and the number of their graduates in the Philippines and Indonesia. The number of private institutes is larger than that of national/public institutions by 8.2 times in the Philippines and by 29.5 times in Indonesia. The number of graduates from private institutes is less than double compared to that of graduates from national/public institutions (1.8 times larger in Philippines and 1.7 times larger in Indonesia). This suggests that many private institutes have a smaller number of students than national/public ones.

The number of students who completed doctoral programs was 1,522 in the Philippines and 644 in Indonesia in 2004, respectively (for Indonesia, data refers only to national/public institutes). For the Philippines, students majoring in natural sciences were as low as 6.0% among students who completed doctoral courses. As shown in Table/Chart 61, international comparison of natural science doctoral degree holders shows that the number is smaller in these countries than in Japan, the U.S., and Korea (i.e., the number of doctoral degree holders per thousand population in the Philippines and Indonesia in 2003/2004 was less than one-fiftieth of that of those three countries[21]).

Table/Chart 62 shows the latest academic backgrounds of university faculty members in the Philippines and Indonesia. Faculty members with only a bachelor's degree assume a dominant share in both countries (59.9% in Philippines and 39.0% in Indonesia), while doctoral degree holders accounted for 9.1% and 5.4%, respectively. Both countries show that the percentage of faculty with a doctoral degree is higher in national/public institutes than private ones (the percentage of faculty with doctoral degree in national/public and private institutes is 12.8% and 7.3% in the Philippines, respectively, 11.1% and 3.0% in Indonesia, respectively).

[21] It should be noted that in the Philippines and Indonesia, doctoral degrees in natural sciences are often obtained overseas and that overseas students who are planned to return to their home countries are included in doctoral degree holders in the U.S. and Japan.

Table/Chart 60 Numbers of higher education institutes and graduates in Philippines and Indonesia (Above: Per founder, Below: Per degree)

| Item / Founder | Number of Higher Education | | Number of graduates | |
|---|---|---|---|---|
| | Philippines (2004/2005) | Indonesia (2005) | Philippines (2003/2004) | Indonesia (2005) |
| National/Public | 176 | 81 | 140,451 | 170,056 |
| Private | 1,443 | 2,391 | 246,469 | 282,642 |
| Total | 1,619 | 2,472 | 386,920 | 452,698 |

Source: Philippines: Academic Year 2004-2005 Higher Education Statistical Bulletin
http://www.ched.gov.ph/statistics/index.html
Indonesia: Indonesian Science and Technology Indicators 2006, Adapted from University Statistics data 1997-2004, and University Directory 2000-2005

Note: Satellite center in the Philippines are excluded. Male-female ratio is 4:6 in the Philippines.

| Item / Program | Number of graduates | | Ratio of Natural Science(%) | |
|---|---|---|---|---|
| | Philippines (2003/2004) | Indonesia(2004) ( National/Public only ) | Philippines (2003/2004) | Indonesia(2004) ( National/Public only ) |
| Bachelor | 315,928 | 90,723 | 34.4 | 40.2 |
| Master | 13,843 | 11,853 | 12.0 | 40.5 |
| Doctor | 1,522 | 644 | 6.0 | 37.9 |

Source: Philippines: Same as the above
Indonesia: Indonesian Science and Technology Indicators 2006, Adapted from Public University Directory, Directorate General of Higher Education-Depdiknas 2004 & 2006

Table/Chart 61 International comparison of doctoral degree holders

| Country | Year | Total Ph. D. holders | Natural Science Ph. D. holders | Population (in thousands) | Number of Ph. D. holders in Natural Science per thousand |
|---|---|---|---|---|---|
| Philippines | 2003/2004 | 1,522 | 92 | 81,172 | 0.001 |
| Indonesia (National/Public only) | 2004 | 644 | 244 | 217,587 | 0.001 |
| Japan | 2003 | 16,314 | 6,830 | 127,718 | 0.053 |
| United States | 2003 | 40,710 | 19,477 | 290,796 | 0.067 |
| Korea, Rep. | 2002 | 6,690 | 3,035 | 47,615 | 0.064 |

Source: Philippines and Indonesia: Same as Table/Chart 60.
Japan, US and Korea: Based on NSF2006

Note: Figures of Japan, US and Korea do not include Social/behavioral Science of NSF2006 for comparison with the Philippines and Indonesia.

Table/Chart 62 Highest educational attainment of faculty in Philippines and Indonesia

| Degree / Founder | Philippines (2004/2005) | | | | | | Indonesia (2003) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bachelor | Master | Ph. D. | Other | Total | % of Ph. D. | Bachelor | Master | Ph. D. | Other | Total | % of Ph. D. |
| National/Public | 19,385 | 11,869 | 4,587 | 43 | 35,884 | 12.8% | 24,103 | 28,472 | 6,851 | 2,555 | 61,981 | 11.1% |
| Private | 47,260 | 22,209 | 5,518 | 354 | 75,341 | 7.3% | 55,653 | 31,253 | 4,283 | 51,368 | 142,557 | 3.0% |
| Total | 66,645 | 34,078 | 10,105 | 397 | 111,225 | 9.1% | 79,756 | 59,725 | 11,134 | 53,923 | 204,538 | 5.4% |
| Total % or degrees | 59.9% | 30.6% | 9.1% | 0.4% | 100% | 9.1% | 39.0% | 29.2% | 5.4% | 26% | 100% | 5.4% |

Source: Philippines: Same as Table/Chart 60
Indonesia: Indonesian Science and Technology Indicators 2006, Adapted from University Statistics, Directorate General of Higher Education, Department of National Education, 2003

We summarize the development of higher education and major characteristics of research functions in both countries in the following part. Philippines attempted to follow a U.S. model, but its research and service functions are still undeveloped. Indonesia improved higher education through assistance from the Western countries, while it is pointed out that the essential objectives and spirits of Indonesia's higher education indicate indigenous characteristics.

[Philippines[22]]

The Philippines' higher education is strongly affected by the U.S. However, the localization of research did not make any success except the University of the Philippines. Since the R&D of business entities is limited to quality assurance, job opportunities for people specializing in natural sciences are limited to teaching and other few areas. Many low-cost courses have been introduced by private higher education institutes because the government neither has plans nor offers advice concerning higher education. Commercial courses attract many students, followed by pedagogy, which has caused mismatch in human resources needed in the industrial sector. Research facilities and equipment are not sufficient in natural sciences and students are concentrated in other areas that promise many job opportunities overseas, including medical study/nursing. This has caused the outflow of many medical doctors (there was a time when almost 75% of the graduates majoring medicine got a job overseas).

There are many doctoral degree holders who do not return to the country after getting the degree from graduate school overseas, which is one of the factors preventing the development of a higher education system in the Philippines. The quality of higher education has deteriorated due to the country's economic problems and the salary of faculty has declined due to weak peso. As a result, teaching at universities has become an unattractive career path for excellent students. Faculty members are still required to give lectures of 24 credits except in national or some advanced private universities; thus, they have little time to prepare for lectures or attain higher degrees. Lectures in social science or natural science are nothing but transmission of out-of-date knowledge under these circumstances. The number of university students is large in the Philippines, yet it is not too high for a developing country, considering low-level university education there[23].

[Indonesia[24]]

Modern higher education in Indonesia is based on Gadjah Mada University, the first university established in 1946, and the University of Indonesia, established in 1950. These institutions can be characterized as placing emphasis on nationalism as well as preferential treatment of Indonesian staff. Behind the deterioration of quality of education during the period, there is a factor including insufficient facilities due to inability to catch up with a rapid expansion of higher education, low quality of enrolled students, and nationalization of universities. For example, at Gadjah Mada University, Indonesian was used as the teaching language, which caused problems in the beginning as follows: Insufficient vocabulary for high-level science and technology; scarcity of books written in Indonesian; lack of Indonesian faculty members, and most foreign faculty members' inability to give lectures in Indonesian. Some overseas countries launched technical assistance to Indonesia from 1955, which is said to have contributed to promotion of sustainable expansion of higher education in Indonesia.

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22 Source: *Gonzales, 1993, Gonzales, 2006*

23 According to WDI 2007, higher education enrollment rate was 28.0% in 2005 in the Philippines, while that of Indonesia was 17.0%. The rate was 27.1% in 1991 in the Philippines, while that of Indonesia was 9.2%. Both countries are categorized as lower-middle income countries, yet the average higher education enrollment rate of the other 36 nations in the same category was 15.3% in 1991, thus the rate of Philippines is considered to be very high in general.

24 Source: *Cummings & Kasenda, 1993*, and *Abdul Muftal, 2006*

However, the rapid development of higher education has caused many problems. There has been a long-term concern for lack of professors who have an advanced specialty and degree. Weak relevance between education and research activities and professors' engagement in non-academic activities outside campus (consultancy or private business to make up for low salary from teaching at national universities) are also pointed out. The situation of private universities is more serious; many of the part-time professors are full-time teachers of national universities. Much of the running expenses are disproportionately allocated to the salary of the faculty due to shortage of funds, and only 22% is used as research expenses. The appropriateness of education is another problem. It is pointed out that students majoring in natural sciences has been smaller in number than those majoring in humanities and social sciences since the early 1980s. Subsequently, the government expanded investment in natural sciences, yet enrollment to these fields has been slow to grow. Behind the scene, there is an insufficient response of national universities to expanded needs for higher education and private sectors have provided low-cost education by establishing schools of humanities and social sciences instead.

### 5.2.2 Measures concerning the promotion of science and technology in two countries

[Philippines]

Research measures:[25]

The Commission on Higher Education (CHED), the governmental institution in charge of higher education in the Philippines, developed the National Higher Education Research Agenda 1 (NHERA1) targeting for 10 years between 1998 and 2008 to indicate the directions/priority of research conducted at higher education institutes in the country. Subsequently, NHERA2 was planned for another 10 years between 2009 and 2018.

NHERA1 focused on nine categories[26] and allocated 376 million pesos (approx. 720 million yen, where one yen equals 0.52 pesos as of January 2010) for 10 years. Furthermore, the establishment of 12 local research centers was included in the initial target to realize the project (nine centers have been operating six years, and six for three year, according to a report of 2009).

NHERA2 has set four targets including the improvement of research capability/productivity in higher education and the utilization of research outcomes in the Philippines. For example, scholarship to graduate students and subsidy to research activities as well as enhancement of graduate school education in the priority fields are included in the items concerning the improvement of research capability. With regard to the enhancement of research productivity, the systemization of incentives (e.g., research subsidy and rewards) for faculty members to conduct research is included.

[25] Source: National Higher Education Research Agenda- 2: NHERA2 2009-2018. Office of the President Commission on Higher Education CHED 2009

[26] Priority fields include Science and Mathematics, Education and Teacher Training, Health and health profession, Information and Communication Technology, Engineering, Maritime and Architecture, Agriculture, Environmental Science, Humanities, Social Science, and Other disciplines as identified by the Commission.

Research support to graduate school:[27]

In the Philippines, the Engineering Research and Development Technology (ERDT) project was launched in 2007 with the aim of supporting graduate students of engineering departments as a seven-university consortium under governmental support. The program aims to realize research promotion measures; greatly increase the number of people who complete graduate courses; improve the quality of engineers; and develop research culture[28]. Major means are as follows: promotion of engineering R&D; scholarship; development of infrastructure; improvement of the ability of teaching staff (a total budget of 6.5 billion pesos for 10 years (about 12.5 billion yen)).

[Indonesia[29]]

Research support:

It has been pointed out that universities in Indonesia have the following problems concerning research activities: A gap of research ability among universities/categories, a low level of research culture in academia, and restriction on research funds. Programs including Young Researcher (US$1,200 for eight to ten months) and Basic Science (US$1,800 per year for two years for basic research) were useful assistance to develop the research culture between 1990 and 2000. According to the summary of 400 research projects backed up by multiple-year research grant, each project spent an average of US$5,000 per year and gave the following deliverables: one source in domestic journal; 0.15 sources in international academic journals; one presentation at a domestic seminar; and 0.33 presentations at an international seminar. A breakdown of representative researchers is as follows: professor (11%), doctoral degree holders (54%), master's degree holders (28%) and bachelor's degree holders (11%). In the meantime, females accounted for 16% among them. A breakdown of category is as follows: Engineering (20–30%), health care (10–20%), agriculture (20–30%), basic research (10%), education (10%), and other (6%). The rate of winning research grant was 16%.

Research support to graduate school:

There is the University of Research for Graduate Education (URGE) as a project to improve research ability and education at graduate schools. The project was conducted based on loans from the International Bank for Reconstruction and Development and the governmental funds between 1995 and 1999 (extended to 2001). The contents of the project are as follows: grant to graduate students, fellowship to attract excellent students to graduate schools in the country, overseas study based on a sandwich program[30], improvement of domestic journals with peer review, and organization of international seminars.

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27 http://www.engg.upd.edu.Ph. Downloads/UPAEpgc.pdf

28 The term "research culture" and the necessity of developing it were often heard during the interviews. During the interview of the Indonesian Ministry of Science and Technology, it was pointed out that the term may have a different meaning depending on person. It can be defined as attitudes/trends of a group conducting research activities according to the origin of the term (to find a new fact/truth and the process of doing so [research] and an aggregate of attitudes/actions that are common in a certain group [culture]).

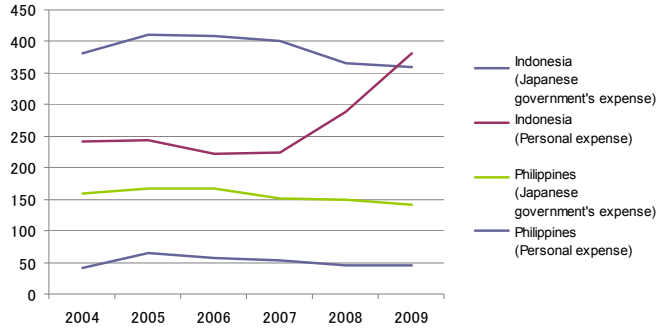
29 Source: *Koswara Tadjudin, 2006*

30 A system whereby students can receive advice on academic writing at another universities and conduct field research for a certain period during doctoral degree courses. It enables students to receive more diverse guidance by "sandwiching" overseas study between their doctoral degree courses, which will promote research activities.

### 5.2.3 Indonesian and Philippine students studying in Japan (graduate school in natural sciences)

Table/Chart 63 shows movements in the number of Philippine and Indonesian students studying in graduate schools in Japan with a major in natural sciences (Science, Engineering, Agriculture and Health) between 2004 and 2009. Both countries show that students who study abroad at Japanese expense are slightly declining, yet the number of such students is greater in Indonesia than in the Philippines (by 2.5 times for students studying at Japanese expense and 5.2 times for those at own [private] expense). The number of Indonesian students who study abroad at their own expense began increasing in 2007 and exceeded those who receive Japanese expense in 2009[31]. Students from the Philippines and Indonesia account for 8.5% and 3.1% (national expense) and 3.4% and 0.6% (own expense), respectively, of the total overseas students majoring in natural sciences at graduate schools in Japan, on average for six years. If we compare the number of students majoring in natural sciences with those in other fields such as humanities and social sciences, the difference is seven times in Indonesia (Japan's expense) and five times in the Philippines (Japan's expense), while it is four times in both countries concerning individual expense.

Table/Chart 63 Movements in the number of Indonesian and Philippine students majoring in natural sciences at graduate schools in Japan




Source: Data of Japan Students Services Organization

## 5.3 Results of the domestic interview survey

According to the interview with eight researchers, it has been confirmed that government measures including the acceptance of foreign students and international cooperation initiated exchange with these countries and that coauthorship was mainly conducted in a form of a joint papers with students who returned to their home countries or acknowledgements to resource providers. The interviewees expressed difficulty of conducting a joint research with researchers from those two countries on equal terms in general, and the following ideas were proposed with regard to future support: Research education for foreign students based on an assumption that they will continue research after getting a degree in Japan and returning to their home countries; sustainable research support to researchers after they return to their home countries. However, individual experience may vary depending on researchers whom the interviewees met in the Philippines and Indonesia; thus, perception about researchers of those countries and joint

[31] Under this definition, students studying at their own expense include those who are sent from foreign governments.

research seems different to some points. We will describe the results of the interviews in the following part. The position, subject fields, and institution of each interviewee are shown in parentheses.

### Reasons for starting exchange with the Philippines and Indonesia

A university I used to teach at was providing assistance to key science/engineering universities in Asia based on budget of the Japan Society for the Promotion of Science, which gave me an opportunity to join a project sending teaching staff to Indonesia. This is the reason I became involved with exchange with the country and started accepting overseas students (Professor ①, Physics, National university).

I have had relations with the Philippines and Indonesia since 1980, when I was an assistant professor. I took part in a project led by the Japan Society for the Promotion of Science then. In the Philippines, I especially engaged in offering advice to students and providing lectures under a joint graduate school program, and then I developed personal relationships. Japan has been investing in higher education and offering research assistance in developing countries for several decades, yet I doubt if they reflect the activities. (Professor, Pharmacology, Private university)

A professor who was my supervisor signed an acceptance of foreign students and then a relationship with faculty members of a university in the Philippines has started. We have constantly accepted overseas students and held several international workshops/mutual visits with the university, which has developed into academic exchange between institutes. (Professor ②, Physics, National university)

Working at an international organization in the Philippines was a part of personnel transfer and it was not my wish. Overseas assignment is not highly evaluated as it used to be. Rather it is a disadvantage to work at a research lab in developing nations as you may miss out the latest research trend. (Project leader, Bioresources, Independent research center)

I have been engaged in research on a certain ingredient of plant resources. I have developed a relationship with Indonesia as I could find plants containing the ingredient in the country. It is difficult to bring plants in Japan due to the Convention on Biological Diversity; thus, I have been developing personal contacts through a various route. (Professor, Pharmacology, Public university)

### Form of international coauthorship

I visit Indonesia two to three times a year including invitation for about two weeks each and continue the joint research. Indonesian researchers whom I taught gather along with my visit and they write a paper as a team while sharing roles and conducting experiments. (Professor ①, Physics, National University)

Philippine coauthors are my students who have returned to the country. (Professor ②, Physics, National university)

I often write a joint paper with a team leader of the international research center, which I used to work for. Joint research is appreciated as the number of papers is weighted for recruitment/evaluation. Approximately 2,000 staff members based on the research laboratory, many team leaders (about 60 in number) selected from international recruitment are mostly Western researchers, and there are factions by race in the research laboratory. A research theme is set by the whole laboratory and a joint research is conducted as necessary. Japanese researchers tend to engage in a joint research with very close, reliable researchers, yet foreign researchers seem to be different. (Project leader, Bioresources, Independent research center)

It is very difficult to obtain materials (plants) in my research field. It is not too much to say that gathering materials (plants) accounts for half of my job. Thus, I include the name of materials-provider in my research papers. It can be said that my work is based on the division of labor between local researchers and Japanese researchers rather than a joint research with local researchers (i.e., local researchers provide plants and Japanese researchers conduct analysis/academic writing). This sort of segregation of duties occurs because it is not impossible to engage in research on site, but a researcher who first finds the effectiveness of plants' ingredients collect materials and conduct analysis. (Professor, Pharmacology, Public university)

A role sharing at research between Japanese researchers and researchers from developing countries is not equal. Researchers from developing countries are "guests" and it is a key point if they can get out of the situation. In Japan, it may be a problem that the acceptance of researchers from developing countries itself is taken as an actual result and achievement including joint papers is not required. (Professor, Pharmacology, Private University)

### Incentives to writing research papers

Academic work (paper) will be evaluated as achievement in promotion at universities in Indonesia. (Professor ①, Physics, National university)

Promotion at De La Salle University in Philippines is based on a point system and presentation in international journals and participation in conferences are given high points. However, it is difficult for Philippine researchers to present a paper in international academic journals by themselves and international coauthorship could be an effective way. Therefore, Philippine researchers seem to have a huge incentive to present a paper in international journals and to engage in international coauthorship leading to international presentation. (National university, Physics, COE special assistant professor)

I do not see any incentives to write papers among researchers of both countries. I guess they do not have a system to utilize research. They actively engage in academic writing at overseas universities to get doctoral degree but may be satisfied when getting a job in their home country. (Professor, Pharmacology, Private university)

Challenges in conducting research

: System to support research

For Indonesia, the salary of faculty is rather low and they have to have a part time job to make up for a shortage, which prevents them from focusing on research. (Professor ①, Physics, National university)

For the Philippines, a research level is a problem (e.g., it is difficult to produce research outcomes that will be qualified to present in international journals). Behind the problem, there are the following reasons: responsibility of teaching is too heavy, experimental equipment is not organized and late behind a theoretical trend, and it is difficult to access (subscribe to) international journals as they are expensive to them. A problem concerning teaching staff can be considered as well; students know that faculty members in their 50s are not engaged in a world-level research, although they have a degree. As a result, some of my students will remain in Japan as teachers or will get a job at a research laboratory in Canada after obtaining a degree in Japan and they do not want to return to their home country (Philippines). (Professor ②, Physics, National university)

: Development of researchers

A challenge to Indonesian researchers is to be independent. Indonesian researchers have made results of joint research; however, they are difficult to think logically and pursue research by themselves without assistance from others. I have an impression that they can collect data under direction, yet an ability to judge data and to think deeply is not fully cultivated. (Professor ①, Physics, National university)

Many of the Philippine staff working at international research laboratories are graduates of the University of the Philippines with a high level of knowledge and ability, yet they do not improve probably because their treatment is not good enough at the laboratories. Research is conducted based on the division of labor and although it depends on a team leader, a leader is in charge of collecting funds and writing a paper, while general researchers are just supporting the collection of data, which prevents them from developing scientific thinking or insight. (Project leader, Bioresources, Independent research center)

There are a few local research professionals, but they are spread like dots and do not expand. I think that the number of researchers in the Southeast Asia is very small. Their level would not be improved unless a competition factor, such as scientific societies, works, yet I do not think scientific societies are active in the Philippines and Indonesia. (Professor, Pharmacology, Private university)

: Attitude/ behavior of researchers

We are required to make overseas students obtain a doctoral degree in three years due to financial restrictions. It is necessary to have them make a result that can be presented in international journals for a fixed period. Thus, we set a story in advance so that they can conduct experiment effectively, which may prevent them from thinking deeply and have effect on their attitude toward research. (Professor ①, Physics, National university)

Japan has been offering assistance to Southeast Asia for a long time, yet I feel the difference of values; researchers in Southeast Asia consider research work as just one of many jobs and their attitude toward research (to search scientific truth) is also different from ours. If a sense

of values toward research is not the same, it is difficult to conduct a real joint research. I am afraid that Southeast Asian researchers who can share the same value with us Japanese researchers will go to the other advanced nations besides Japan. (Professor, Pharmacology, Private university)

### Reasons for selecting Japan as destination

Reasons for selecting Japan as the destination of studying abroad at their own expenses are as follows: Japan is excellent in international competition in my field; there is a connection among professors between universities of both countries; I have an impression that the U.S. is excessively competitive; geographical closeness (e.g., time difference or close to my families); popularity of Japanese culture, including "manga" (comic/cartoon); sense of security that my acquaintance is studying at the research lab that I belong to in Japan. (National university, Physics, COE special assistance professor)

### Opinions on Japan's academic assistance

Even if we make foreign students get a degree through overseas study, it will not be linked to a continuous independent research after they return to their home countries. It is necessary to provide guidance based on an assumption that they will continue research after getting a degree in Japan and returning to their home countries. For example, we have them engage in the cutting-edge research in Japan, yet it will be difficult to continue the research in their home countries. I would say that it will be better for them to conduct research without spending so much expense and instead show their originality based on subjects connected to their local history or culture. (Professor ①, Physics, National university)

We have a good system including a program to support overseas study at national expense in Japan. Many of the foreign students are faculty members of Philippine universities and they send excellent students because of the history of the exchange program. However, their post-degree conditions are the issue. I would propose two suggestions concerning their return to home countries after getting their degrees. First, several students should return to their home countries at the same time, which could allow them to attend international meetings by sharing teaching responsibility and continuing research even if they belong to organizations with little research achievements. Second, economic support with relatively free usage should be provided, even if it is small. For instance, travel expense for re-visiting Japan for a short time for research as well as financial assistance to alleviate their teaching responsibility in home country while they stay in Japan. If research expense paid by the Japanese government can be used for the employment of local research assistants, research time would be expanded and the wage gap between countries would be effectively utilized. (Professor ②, Physics, National university)

An open evaluation will be required regardless of private or academic sectors if excellent foreign students wish to work in Japan after getting a degree. I have a feeling that a fair evaluation is not necessarily conducted by Japanese universities trying to hire foreigners as teaching staff. (Professor ②, Physics, National university)

### Development of local research activities

It is difficult to attract people to educational/research institutes if they know that there is no job opportunity available even if they graduate university or graduate school. Tropical countries are rich in resources and they should utilize them to attract researchers from all

over the world like Singapore, if I speak from a perspective of global brain movements. With a facility allowing for unlimited research, brain would gather from all around the world. However, the current situation is not what it should be (i.e., enclosure of resources and brain drain can be seen at the same time). (Professor, Pharmacology, Private university)

## 5.4 Results of the overseas interview survey (Philippines and Indonesia)

We summarize the results of the interview survey in both the Philippines and Indonesia, and then describe the results for country. Each country's results are followed by a summary and a detail description. The position, the institution (and the specialty as needed) of each interviewee are shown in parentheses followed by the description.

### 5.4.1 Summary of the results of the interview survey on two countries (Philippines and Indonesia)

#### Recent governmental or university support for research activities

The Philippine government has formulated research promotion measures and supports a project to enhance graduate schools of Engineering. The Department of Engineering of the University of the Philippines has increased the number of faculty members and reduced their educational responsibility. Furthermore, they have increased the salary of faculty, which is often reported as exceptionally low. In Indonesia, University of Indonesia has introduced a professor post that focuses on research (with higher salary and less teaching responsibility), and the Bandung Institute of Technology offers rewards to internationally published scholarly papers.

#### Academic career path of researchers and their reasons for returning to home countries

All the target researchers have experienced research training overseas for a doctoral degree. The main reason for returning to home countries after getting a degree was as follows: For Philippine researchers, family comes first; for Indonesians, an agreement with the sending organization (e.g., researchers are required to serve for a certain period [usually double the duration of overseas study + one year] after returning home) and willingness to contribute to the country are included in addition to family matters.

#### Incentives to engage in international coauthorship

International publishing of scholarly papers is highly esteemed as accomplishments in the target universities in the Philippines and Indonesia. In the Philippines, researchers are required to continuously present papers in international journals to be promoted to a professor, while in Indonesia, there are national standards for the evaluation of employment/promotion of faculty (i.e., certain points are given according to accomplishments) and international publishing of research results is awarded high points.

#### Partiners and advantages of international coauthorship

Partners of the coauthors are mainly academic supervisors of recipient universities or acquaintances from the overseas post doctoral period. Coauthorship is often conducted with academic supervisors immediately after researchers have returned to their home countries; however, they gradually come to engage in joint writing with co-workers or domestic researchers including their students. In many cases, international coauthorship improves the quality of papers due to availability of a good experimental equipment by coauthors who belong

to institutions in developed countries. Academic supervisors have a substantial amount of international publishing as well as credibility within the academic community; thus, it is also pointed out that there are more opportunities to present papers in international journals under international joint writing with them.

#### Treatment of faculty and research environment

The following factors were pointed out as constraints of research activities: Insufficient experimental equipment or fewer subscriptions of international journals; heavy educational responsibility; lack of efficient research framework due to outflow like overseas study of excellent graduate students (young faculty) and inefficiency in administrative process. In the Philippines and Indonesia, “research culture” is not strongly rooted; thus, even if researchers have a strong willingness, it is difficult for them to keep up motivation for research. Development of researchers in the next generation would be their next challenge due to insufficient treatment of faculty such as low salary and lack of faculty members with ability to provide research traing.

#### Support from Japan

The Japanese Embassies in the Philippines and Indonesia concerns that the status of international students who have completed study in Japan (i.e., whether they return home or remain in Japan) is not well known and they are not well utilized after returning to their home countries. JICA has launched a project to support the Engineering departments of major universities in ASEAN, which is highly appreciated among the faculty members we interviewed in both countries, for its many advantages, including opportunities for university teaching staff in the region including Japan to know each other.

### 5.4.2 Results of the interview survey in the Philippines

#### (1) Summary of the results

#### Measures taken by the government concerning research promotion

The Philippine government (CHED) has developed measures to promote research activities in higher education (National Higher Education Research Agenda-2 2009–2018) and been supporting graduate students in the field of Engineering based on ERDT. Behind the scene, there is a concern that the number of researchers per population and R&D investments as a percentage of GDP are relatively small compared with adjacent Asian nations including Vietnam.

#### Change in the research environment at universities over the past 10 years

We visited national University of the Philippines (UP) and private De La Salle University (DLSU). They are said to be top-level science/engineering universities in the country. Many interviewees said that their research environment has been greatly improved over the past 10 years at the science/engineering department of both universities. Improvements were described as follows: Online subscription of international academic journals has become possible (DLSU); the number of faculty members has increased, which helped reduce teaching responsibility, and the salary, which has been said to be exceptionally low, has been improved (UP); a program to support graduate students (ERDT) through financial assistance and opportunities to presenting research outcomes has been launched (DLSU, UP).

### Incentives for academic writing and restrictions

Faculty positions are precisely defined as that professor is divided into Full, Associate, and Assistant. For DLSU, these positions are further divided into ten, seven, and seven stages, respectively. Faculty are required to have a doctoral degree and continuously present research papers to advance to positions above Associate Professor. The presentation of academic papers in international journals is awarded particularly high points, which means that academic publishing is linked to promotion.

Restrictions on research activities are as follows: Time (it takes a long time in administration, paper work, and teaching) and inefficient office administration (it takes a while to purchase equipment including experimental units).

### Academic career path of researchers and their return to home country

All the target researchers have received research training overseas for a doctoral degree. Among them, one professor has obtained a degree in the Philippines, while others have attained a degree in foreign countries including Japan and the U.K. Reasons for returning to the Philippines were mainly family matters.

### Faculty members and education at graduate school

For University of the Philippines and De La Salle University, almost half of the faculty of the science/engineering department are doctoral degree holders, which is a share higher than the overall rate in the Philippines (10% or less as a whole). Nevertheless, both government officials who are in charge of research promotion of the Philippine and university faculty wish to increase the percentage of professors with a doctoral degree in those universities. They seem to expect much more foreign companies start their business in the country as well as hope to improve the quality of faculty.

Lack of research mentors is one of the problems concerning education at graduate schools in the Philippines. In the meantime, there is a great concern for excellent students to leave the country to study abroad. Thus, professors and government officials often use a sandwich program when studying overseas. According to the Japanese Embassy in the Philippines, the number of students studying abroad has been growing in the fields of humanities and social sciences and JICA's Human Resource Development Scholarship (JDS) has been mainly supporting public employees to study abroad in line with their country-specific support programs. Although some improvements have been seen recently, the status of students after completing overseas study was hardly tracked. It is pointed out that a follow-up of students who have returned to the Philippines is critical as well as offering incentives for them to keep contact.

### Support from Japan concerning higher education/research

Some deans and faculty members are receiving various academic supports from Japan, such as research guidance for a degree. Furthermore, a project of JICA, AUN/SEED-Net has been highly appreciated because it benefits researchers by allowing them to communicate with faculty members of other universities in Asia, including Japan, as well as provides financial assistance. A network of faculty members of universities within ASEAN will allow exchange among faculty members, including joint research proposals and mutual visits, which will also broaden the alternatives of the destinations of overseas study.

### Request for joint research with Japan

It is expected that the Philippines and Japan conduct joint research in more equal positions by utilizing the strength of each country (e.g., Japan has many researchers and research equipment; the Philippines is rich in natural resources), eventually leading to the promotion of research activities in the Philippines.

### Other

We found three female researchers with doctoral degree: the deans of the Department of Engineering at both UP and DLSU as well as the director of the R&D department at CHED. The female ratio is also high in both universities: Females account for over half of the students majoring in Engineering at DLSU and about half (47%) of the students majoring in Engineering at UP.

## (2) Results of interviews

### [Interview on research activities in the Philippines]

#### ① Research environment

##### Research policy and status in the Philippines

The National Higher Education Research Agenda 2 was developed targeting for 10 years between 2009 and 2018. At the same time, the achievement of Agenda 1 (1999–2008) has been reviewed. The number of researchers per population and R&D investments as a percentage of GDP are excessively lower than those of adjacent nations with the same economic level. Vietnam has been rapidly expanding R&D investments, and the Philippine government also has been urgently promoting investment to R&D due to an awareness that the Philippines lags behind them, which is linked to an active assistance to UP. Our first priority is to increase the number of doctoral degree holders. (Director IV, Office of Planning, Research & Special Project, CHED)

I am worried about the situation of research activities in the Philippines compared with adjacent nations. Research activities in the Philippines seem to be improving according to a benchmark of UNESCO, yet I am still concerned about the country lags behind Vietnam and Thailand. (Dean & Professor, College of Engineering, DLSU)

As a result of reviewing dissertations, I came to question the quality of the papers (i.e., many of them are stereotyped and very few are creating new knowledge). Without scholarship, students are forced to work and study on a part-time basis; thus, it takes time to get doctoral degree. Furthermore, most dissertations are not to be published, which is also a problem. For faculty members, they do not conduct research as they have too much responsibility in teaching. I hear that faculty members are engaged in research activities on their own initiative in Japan. I would like to know about the reason. (Director IV, Office of Planning, Research & Special Project, CHED)

##### Change in research environment

The research environment in DLSU has greatly changed for these 10 years. We can access (download) international academic journals on the Internet, which has a great effect on improvement of research efficiency. I also feel that research funds and scholarship are increasing every year. The next challenge for research is to shift to a system in which a good

research can be launched based on a new noble idea. I think it is necessary to offer education to achieve it and spend the limited funds to make results in an appropriate manner. (Professor, Chemical Engineering Department, DLSU)

The research environment has greatly changed for these 10 years. The number of teaching staff at College of Engineering was around 160 in 2004, which was raised to 207 in 2009 as a result of increase in the number of teaching staff, with a view to mitigating teaching responsibility. (Dean & Professor, College of Engineering, UP)

### Challenges for research activities

Time is the restriction on research. I would like to solve the problem for the younger generation. (Dean & Professor, College of Science, UP)

Time for research is the biggest restriction. I cannot ignore teaching because there is something that only I can teach. Working hours at the university are officially fixed to 40 hours per week, yet they are actually over 50 hours. I spend 30–40% of the working hours to teach and about 40% to research. Given working hours at home is included, the percentage of research accounts for more than that. (Professor, Chemical Engineering Department, DLSU)

It takes time to buy goods/equipment, which is the biggest restriction. It will be lucky if you can receive your order in six months after ordering it. (Dean & Professor, College of Engineering, UP)

### Ideas for research

If I compare myself to a person at the same level in an advanced country, I see that financial resources I can spend on research equipment are extremely small in the Philippines. Therefore, I limit my research method to computer modeling. I receive funds mainly from the university, the government, and the private sector in addition to financial supports from overseas institutions (e.g., EU, JICA). (Professor, Chemical Engineering Department, DLSU)

### Promotion of science and technology in the Philippines

One of the reasons for the inactivity of science in the Philippines is that there are many private universities and they tend to provide education in humanities and social sciences, which is cheaper to conduct, rather than in natural sciences. However, I think that cultural backgrounds including the characteristics of being fond of arts also lies behind the situation. (Professor, Marine Science Institute, UP)

## ② Academic publishing

### Incentives for academic writing and evaluation of professors

Motivation for academic writing is to create something original and enjoy competition and collaboration with researchers of the same age. (Professor, Chemical Engineering Department, DLSU)

Faculty positions are precisely defined as follows: Full Professor (Stages 1–10), Associate Professor (Stage 1–7), Assistant Professor, and Lecturer. A continuous delivery of research results as well as a doctoral degree is required to go above an Assistant level. For a Lecturer, one-year experience, research results (i.e., publishing papers in prestigious international academic journals that have a great impact factor) and a master's degree are prerequisites to an Assistant. Presentation of research results is a key item that earns the highest points, while

teaching is exposed to evaluation by students as well; “good” is acceptable and “outstanding” is much better. This evaluation system has not greatly changed since 1980 as far as I know. (Dean & Professor, College of Engineering, DLSU)

### Partners and advantages of international coauthorship

Coauthors would vary depending on time. I used to engage in joint writing with my academic supervisor (British professor) quite often five to six years ago and now I sometimes write a paper in a local team or with researchers I met at an international conference. My research subject is concerning computer modeling; thus, 80% of our discussion can be done on the Internet. In case communication through the Internet cannot cover, I make a trip or make a phone call. Currently, I write joint papers with researchers in India, Malaysia, and the U.S. (Professor, Chemical Engineering Department, DLSU)

An advantage of conducting joint research with overseas researchers is that I can use their experimental equipment. For instance, when I conduct joint research with a professor of a U.S. university, I can use their latest experimental equipment. There is one experimental equipment of the same model in the Philippines, which is more than a decade-old and I am not allowed to access as it is installed in another university. This kind of situation can be improved by joint research. (Professor, Marine Science Institute, UP)

## ③ Academic career path and the highest degree of faculty members

### Academic career and return to home country

I had a scholarship of the Ministry of Education, Culture, Sports, Science and Technology of Japan and went to Japan to engage in research for doctoral degree, as I could not have research guidance in the Philippines. I eventually obtained doctoral degree from UP. (Dean & Professor, College of Science, UP)

I have been working for DLSU for 12 years. I got a job at a food company after graduation with a bachelor’s degree, but I re-entered DLSU for a master’s degree and quit the company to get a scholarship. I have been in academia since then. My academic supervisor at DLSU used to study in the U.K. and I also went to the country to have advice in doctoral programs and learnt a lot. I went to the Netherlands and Italy 5 years ago for post-doctoral research. I have decided to return to the Philippines and continue research as I have a family here. (Professor, Chemical Engineering Department, DLSU)

I have received research guidance twice at a university in Japan supported by JSPS. This is a very significant experience and many other UP professors have received the benefit like me. (Dean & Professor, College of Engineering, UP)

I got a job at a paint company after graduating with a bachelor’s degree. The job was not creative or attractive and I left the company in a year, and then I studied at graduate school of UP while teaching at DLSU. However, I had a problem with research guidance at the graduate school and went to Japan to complete a thesis by getting a scholarship from the Ministry of Education, Culture, Sports, Science and Technology of Japan. I have received bachelor’s and master’s degrees from UP and a dissertation doctoral degree (Ronbun Hakase) from a university in Japan. I consider that research guidance in overseas was a perfect timing and best way. (Dean & Professor, College of Engineering, DLSU)

College education: Degree of faculty members

The number of faculty members of Department of Science at UP was 287 in the second semester of 2008–2009. Among them, 149 were doctoral degree holders (52%), which is more than half of the faculty members. Some 40–50 members without a doctoral degree are in school and most of them are exempted from tuitions and studying for a doctoral degree supported by the government's scholarship. (Dean & Professor, College of Science, UP)

Department of Engineering at UP has 210 faculty members. Among them 35–40% are doctoral degree holders, while 35–40% have a master's degree. Many of the faculty members who do not have a doctoral degree are studying for the degree. (Dean & Professor, College of Engineering, UP)

There are 80 full-time faculty members. Among them, 28 are doctoral degree holders while 47 have a master's degree. Many of the master's degree holders are studying for a doctoral degree. Some students in the Doctoral program (51 students) are part-time students. (Dean & Professor, College of Engineering, DLSU)

(Reference) According to the CHED survey in 2004/2005, doctoral degree holders account for 9.1% of the total faculty members in universities in the Philippines (111,225), which however is unbalanced depending on fields of expertise. The percentage of doctoral degree holders is the highest in Humanities (32%) and low in Engineering at 2.2%. The figure is 8.6% in Mathematics , and the average in Natural Sciences is 13.7%.

④ Treatment of faculty and a large female share of faculty

Treatment of faculty

The basic salary for a professors (full professor) at UP is around US$ 600 per month plus other benefits including donation from alumni (US$100-180). (Professor, Marine Science Institute, UP)

The salary at DLSU is the highest level among universities in the Philippines, but this is an average for business people of my age in the industrial sector. (Professor, Chemical Engineering Department, DLSU)

DLSU receive many job applications from faculty members of other universities as it provides incentives for research and salaries comparable to those of multinational corporations.[32] (Dean & Professor, College of Engineering, DLSU)

Salary of faculty is a problem indeed. Faculty's salary at UP are about one-fourth that at DLSU, the top private university in the Philippines. However, we (UP) are trying to increase the number of faculty members as well as their salary by raising funds from alumni and business entities[33]. The government also attempts to raise the salary of the staff. (Dean & Professor, College of Engineering, UP)

[32] The results of the interview survey indicate that salaries at DLSU are three to five times higher than those at UP. Behind the reality, a gap in tuitions is pointed out as well. It is not easy to calculate an average tuition of each university as it varies depending on the major or course. UP states on their website that their tuitions are half or less than those of three major private universities in the Philippines (Ateneo de Manila, La Salle University and the University of Santo Tomas). http://www.up.edu.ph/content.php?r=27&c=27

[33] The salary of national university faculty is according to that of public employees, but UP is allowed to

I consider that raising the salary of teaching staff would result in solving part of the problem concerning teaching/research. (Director IV, Office of Planning, Research & Special Project, CHED)

### Large female share of faculty

I am a female dean, and females account for 47% of the Department of Engineering at UP. I have made a speech with regard to this theme in Japan. (Dean & Professor, College of Engineering, UP)

My daughter as well as I major in Engineering. Currently, female students account for more than half of the students at the Department of Engineering of DLSU. (Dean & Professor, College of Engineering, DLSU)

There are many female professors in universities in the Philippines but they do not seem to be a primary bread earner. I personally have a family business which is different from the business owned by my husband and make money in addition to salary from university. In the Philippines, it takes time to earn a certain amount of money in academia because doctoral degrees are obtained at older ages, which could be one of the reasons for the large number of female faculty members. Of course, males who really like to do research may stay at university but they will probably go to the business industry when it comes to salary. In the past, males were given higher priority because females had a very limited chance to go into university. The situation has changed. Now that females are given opportunities to receive higher education, there are many female faculty members at Philippines university. (Professor, Marine Science Institute, UP)

## ⑤ Challenges of graduate school education and research cooperation/support of Japan

### Challenges of graduate school education

Only about 18% of the examinees can pass the entrance exam to the University of the Philippines and they are excellent students. A problem with graduate school lies in lack of a capable researcher (mentor) who has an ability to offer advice to doctoral students, and we should not blame the low quality of students on basic education. Many professors come to the Philippines from overseas universities to look for excellent students, but we also have an infrastructure and would like to develop a system so that students can choose either to study aboard or to stay in the Philippines. I personally welcome post doctoral education and the sandwich program but I doubt a current study-abroad system that picks up only excellent students. Furthermore, the number of students who obtain a doctoral degree is currently as small as 13 per year; thus, we want to raise it to around 40–50 per year. Access to high-quality international academic journals is another problem. (Dean & Professor, College of Science, UP)

Our doctoral degree program was established only a few years ago inspired by AUN/SEED-Net. Most students are part-time students who have a job at private companies and take time to obtain a degree, but they are turning to full-time students backed up by a scholarship. The current Philippine industry does not require doctoral degree holders. It is a question like “Which came first, the chicken or the egg?”, but I feel it is necessary to raise the number of doctoral degree holders first to increase investments from overseas. A program to support a scholarship to graduate students in the field of Engineering (ERDT)

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decide it independently. (Director IV, Office of Planning, Research & Special Project, CHED)

was launched by a consortium of eight universities in 2007. (Dean & Professor, College of Engineering, UP)

(Reference) A total number of doctoral degree holders was 1,522 between 2003–2004 in the Philippines, among which females accounted for 60% (female: 924, male: 598). The largest number of them (889) obtained their doctoral degrees in the field of education, Engineering and Mathematics/Information Sciences followed, with six people each. In the meantime, nearly half of these doctoral degree holders (709; 46.6%) obtained their degrees from national university.

### Research cooperation/support of Japan

My research laboratory has introduced a Japanese-style research guidance system. A mentor system under which seniors lead (guide) juniors and conduct research as a team is great in terms of learning from each other and sharing results. (Dean & Professor, College of Engineering, DLSU)

ERDT's system to support research funds is an analogy of AUN/SEED-Net. Thanks to AUN/SEED-Net, we can have a network with professors in Asia, which is a great asset. Before the project was launched, I sent students who wish to study abroad to the U.S., but now a professor in Japan comes to my mind and exchange among students in the region (e.g., students in the Asian region can study in the Philippines) can be achieved. Furthermore, I can write a joint proposal with foreign professors in applying for a grant. (Dean & Professor, College of Engineering, UP)

Asian researchers in the field of Engineering are building a network like a big family through AUN/SEED-Net. Japanese universities offer us great support through exchange by AUN/SEED-Net. We would like to develop a relationship which will bring mutual interest, instead of only receiving support from them. (Dean & Professor, College of Engineering, DLSU)

I hope that Japanese and Philippine universities will conduct man joint studies and grant joint degrees. We have natural resources (natural disasters, such as volcanic eruption of Mount Pinatubo, and natural materials) in the Philippines and Japan has many researchers and experimental equipment. (Director IV, Office of Planning, Research & Special Project, CHED)

## [Results of interviews concerning academic support from Japan to the Philippines]

### Selection of Philippine students to study in Japan

We select excellent persons, considering various factors regardless of their fields of expertise. In the past, many of the students we chose majored in natural sciences, but nowadays, we see outstanding applicants specializing in international relations and law, which has resulted in the increase in the number of students in humanities and social sciences. (Special researcher, Japanese Embassy in Philippines)

### Japan's support for foreign students studying in Japan and its challenges

We consider that a program to give a degree to young faculty members of universities in the Philippines would be a cost-effective assistance. Assistant professors of UP are almost ready to become professors and they just need a degree. Thus, it would be easy for Japan to give them a degree, which will help them to get a promotion and will be effective to develop a network between Japanese and the Philippine researchers. (Minister, Japanese Embassy in Philippines)

There is a problem left in terms of utilization of achievements concerning our current support in studying in Japan with a focus on public employees. The salary of public officials in the Philippines is rather low. Therefore, unless obtaining higher degrees through overseas study gives them incentives, such as faster promotion, capable personnel might turn to private sectors or overseas, in which case knowledge/technology they have learned from the overseas study will not be utilized to improve the government's administrative capability. There is nothing we can do with regard to the salary gap within the Philippines (between the private and public sectors) and that between the Philippines and elsewhere. (Minister/ First secretary, Japanese Embassy in Philippines)

I feel that Japan is not paying enough attention to the follow-up of students after studying in Japan, as indicated the lack of information on whether they have returned to the home country. The current study program for foreign students does not take full advantage of resources produced through overseas study. The alumni associations of Western universities are well structured, which is because they will bring benefits to both universities and alumni (i.e., university collects donation from alumni, while alumni develop a network for business). (Minister/First secretary/Special researcher, Japanese Embassy in Philippines)

Japan's educational support for the Philippines

JICA's country-specific support program for the Philippines focuses on science and mathematics in the primary and secondly education. JICA has implemented a project to develop teachers in these fields in cooperation with UP. Currently, there are two kinds of systems concerning higher educational support in the Philippines: One is AUN/SEED-Net and another is assistance to students who study in Japan. Free aid to those students has started since April 2007. One hundred and fifty-nine Filipinos went to Japan for study between 2003–2009 and 109 have completed their study. We used to choose as students sent to Japan personnel who belonged to public or private organizations without any distinction, but now, we limit students to government officials who will go into a master's course because we found that students from private institutions tend not to return to the Philippines. (Staff of the JICA office in Philippines)

### 5.4.3 Results of the interview survey in Indonesia

(1) Summary of the interview survey

Actions of the Indonesian government concerning research promotion

Several ministries provide competitive funds for universities in relation to themes in their fields. However, the concern is that cooperation between ministries or among business, academia and the government is scarce and that R&D investments from the private sector are rare. Furthermore, a low salary of national university faculty, who are public employees (although national universities are turning to independent corporations one by one), and a low salary strict office restrictions of researchers at governmental institutes are pointed out as fundamental restrictions on the development of research in Indonesia.

Change in the university research environment for the last decade

Nearly half or more members of the faculties to which the interviewees belong to are doctoral degree holders, and the rate is higher in younger generation. Changes they experiences for these 10 years are the increase in the budget for research and the number of research projects, and the

enhancement of research activities in multidisciplinary fields and through international cooperation (UGM). A system to raise the salary of faculty members who have published many sources and to offer bonus to academic publishing has been established in order to push up the position of university in the international college ranking (UI).

### Incentives for and restrictions on academic writing

There is a national guideline for the evaluation of researchers, under which the presentation of papers in international journals is highly evaluated. Motivated Indonesian researchers have high incentives to engage in international presentation of scholarly papers due to the advantage of international joint writing (e.g., improvement of papers quality, development of trust with international journals[34], and access to domestically unavailable products at overseas meetings). University offers five million rupiah for each paper published in an international journal and DGHE pays 50 million rupiah to certain sources, yet it is said that only a small part of faculty members are engaged in research activities (ITB).

According to the analysis, insufficient English skills and a low analytical capability were pointed out as the background of the small number of papers published by Indonesian researchers in international academic journals (IIS). Insufficient equipment and facilities and the lack of access to academic journals are the restrictions on research activity. Some foreign organizations offer assistance to higher education in Indonesia, yet it is doubtful if offered equipment is effectively utilized. Lack of research funds and low salary of researchers are another problem and some faculty members working for public institutions have a part time job at private university or elsewhere. Furthermore, it is said that researchers should brush up their skills overseas because their research motivation may go down if they are confined in Indonesia.

### Academic career path of researchers and their return to Indonesia

Many of the Indonesian students studying abroad are public employees, including university faculty. This is why they cite as the reason for returning to Indonesia an agreement with the sending organization (i.e., to serve for double the duration of overseas study + one year). Furthermore, they feel that they would be more valuable in working in their home country rather than in advanced nations and that they can better contribute to the country. Family is another important factor.

### Faculty members and education at graduate school

It is the advantage of education at graduate schools in Indonesia that students can have a research theme closely related to the local community. On the other hand, the disadvantage is the small number of graduate students. Since excellent students choose to study abroad, a team-based research system does not function as well as it does in Japan. It may be possible to keep the quality of degrees obtained in Indonesia if presentation to international journals of a certain level is required, yet in reality, there are few faculty members who set these strict conditions, which has not been developed to a systematical action.

[34] People in the scientific community can assume the authors of peer-reviewed papers from their previous presentations at meetings/themes; however, peer review of international academic journals tends to be anonymous in general and it is doubtful if a paper submitted from a developing country has been rejected only because of the author's national origin in case the other conditions are the same. *Cialdini, 2010,* shows in his study that people sometimes obey authority mechanically and presents evidence found through an experiment on contribution of articles to journals that people mechanically oppose a person in an non-authoritative position automatically.

Japan's support for higher education/research

Rich Indonesians can afford to study abroad at their own expense; however, Japan is not included in their destinations. One of the reasons for this may be that there is no agent to offer service with regard to studying in Japan. There is an opinion that studying in Japan is critical not only to learn knowledge/technology, but also to study research attitudes, competitive environment, and hard-working culture. Japan has implemented a project to support higher education focusing on the field of Engineering in Indonesia.

Requests concerning support from Japan

With regard to the education for researchers in developing countries, the following items have been requested: Lectures by Japanese faculty members; a joint degree program between Japan and Indonesia; installation of equipment; and a system that helps Indonesian researchers develop a network with Japan.

(2) Results of the interview survey

[Interview survey on research activities in Indonesia]

① Research environment

Status of research activities in Indonesia

(Research level of Indonesia)

I think that Indonesia puts more priority on the R&D of science and technology that can instantly benefit society than Japan does, in order to allow its economy to play a catch-up. Indonesia may be in the start-up phase of research activities from a macroscopic viewpoint, considering Japan's history of development. (Advisor, Minister for Research and Technology)

Top universities are eager to pay attention to university rankings published by The Times and others to raise their level. Going up the world rankings is one of the nations' political targets and mass media runs a feature as well whenever the ranking is disclosed. Research indices in Indonesia are weak and only a limited number of universities are able to conduct a "real" research. A gap can be identified not only between urban and rural areas but also among 83 national universities. There is only a limited number of teaching staff with doctoral degree in rural areas, and I am afraid that even in whole Indonesia, only a few universities can be equal partners of Japanese universities in joint research. Even for qualified universities, a limited number of teaching staff at certain departments are to be partners. For Japan, faculty members that have obtained master or doctoral degrees from Japanese universities can be considered as a liaison in joint research. (Advisor, DGHE)

(Publication of academic journals and presentation to international journals)

Domestic academic journals which DGHE and LIPI acknowledge are published by institutions and not by scientific communities. According to the latest data (2004), the number of journals is reported to be nearly 2,000. Most journals are written in Indonesian, and only a few international journals in the field of Biology are written in English and peer-reviewed overseas. (Director, Center for Science and Technology development Studies, IIS)

Among the presented research results, only a few will be published in international academic journals. According to the government, problems concerning papers written in Indonesia are

English skills and the ability to conduct analysis. The low quality of sources is attributable to the practice that data is accepted without questioning their backgrounds. (Professor, IIS)

(Partnership of industry, academia, and government)

Status of R&D investment is different between Japan and Indonesia as R&D investment is limited to governmental institutions in Indonesia. A survey on R&D in private sectors is still ongoing as of October 2009 and we have collected 600 responses. Research is active in applied sciences and there is a case that the top pharmaceutical company is conducting R&D, yet in reality, general companies are not engaged in R&D. Lack of cooperation among industry, academia, and government is one of the major barriers to R&D, which has been concerned for a long time. The government's organizational restrictions prevent cooperation. (Director, Center for Science and Technology development Studies, IIS)

Research hours

I spend about 20–30 hours per week for research. Time for teaching is not as many as research. I spend three to four hours per day for research and about 12 hours a week for teaching. (Faculty of Mathematics and Natural Science, UGM)

I spend 20–25 hours per week for research including guidance on experiment and preparation of equipment. I work at home as well and spend Saturday and Sunday for research. (Faculty of Mathematics and Natural Science, ITB)

Challenges to research activity

(Field/category)

The government always asks for research results that will contribute to economic development; however, the research I conduct in my lab does not necessarily produce profits. I think it a problem that enough budgets are not allocated to the fields including disasters such as earthquake and environmental change. (Professor, IIS)

(Research system)

Research culture is not rooted in the university I work for. Posting to international academic journals is not common as presentation to those journals is not a prerequisite to complete a Doctoral course. Contributing articles to international journals is not common among teaching staff, as demonstrated by the fact that most of their international presentations are not scholarly papers but proceedings. A problem with research is that there is almost no access to academic journals. With regard to our organization, we have many undergraduate students, while the number of graduate students is very small, which makes it difficult to develop a hierarchical research team in which seniors guide juniors. High-level graduate students will go abroad for study and other graduate students remaining in Indonesia are part-time students and do not have time to mentor their juniors. (Faculty of Mathematics and Natural Science, ITB)

Time and motivation limit research activity. Management work, including attendance to a research committee held by the Ministry of Education or universities, increased more than before. Teaching responsibility is also heavy. I can keep a high motivation to research immediately after returning from overseas, but it wanes as I work in Indonesia. Research culture is not rooted in this country. You would feel ashamed if you are not engaged in

research at university in Japan; however, this is not true in Indonesia. (Research Coordinator, Department of Physics, Faculty of Mathematics and Natural Sciences, UI)

(Facility)

Lack of equipment/facility is the biggest restriction on research. In the event of a disaster, we have no equipment to see the situation. We can make time somehow but there is nothing we can do with lack of equipment. (Professor and Head of Department of Geological Engineering, UGM)

Poor facility/equipment is the biggest restriction on research. Online access to international academic journals is limited as well. The situation has improved, yet it is not good enough. Even the entire chemistry-related departments are allowed to subscribe two to three journals due to insufficient budget. It takes longer to purchase chemical agents because of the tightened regulations since 9.11. (Faculty of Mathematics and Natural Science, UGM)

The budget for chemical agents is critical in conducting research. Apart from small-sized equipment, we cannot afford expensive facilities, such as MRI. A grant is also competitive and difficult to win. (Professor, Faculty of Mathematics and Natural Science, ITB)

Our institute has received much support from overseas governments, yet some of it is not effectively utilized (i.e., some departments have installed equipment without conducting research). With regard to the selection of target of support, I wish that achievements were properly evaluated and opinions of users were listened so as to choose support recipients that could use facility/equipment in an effective way. (Faculty of Mathematics and Natural Science, ITB)

Overseas funds are used for purchasing facilities, which will require operation skills and running cost. However, we do not have national funds for it and neither machinery nor budget is used effectively. We need not only facilities but also engineers who can properly install and operate them. (Director, Private Research Institute)

Change in research environment

A budget for research has increased for these 10 years. Multidisciplinary fields have grown since the 1990s and their collaboration with sociology/psychology began to increase five years ago. We have financial support for research mainly from oil companies or the government alone before, but now we have international partners, such as multinational companies and overseas governments. (Professor and Head of Department of Geological Engineering, UGM)

We have seen a great change in the research environment for these 10 years. The number of doctoral course students as well as research staff has grown and research funds have increased. The number of international research projects has increased as well. (Faculty of Mathematics and Natural Science, UGM)

A leading competitive fund scheme provides nearly 100 million rupiah (about a million yen) per project, and several hundreds of research projects have received such funds as far as I know. In this grant scheme, the continuity of a project is decided based on evaluation after a year. Both the Ministry of Commerce and the Ministry of Engineering have established other grants for university to support fields that may become industrial seeds; however, it is the problem that bureaucratic sectionalism prevents cooperation of ministries. Incorporation of universities, which is a policy set by the Ministry of Education, seems to be one of the reasons for introducing competitive research funds. The aim of this policy is to promote

competition among universities and revitalize each university by eliminating excessive dependence on the country and excessive centralization of authority. It is expected that the next national plan will include a project to enhance research ability, which however seems to focus on the improvement of competitiveness of university as a whole rather than expect that research will contribute to the development of a certain industry. (Advisor, DGHE)

Ideas for research

A sustainable theme for research that could be continued in home country from the beginning should be prepared so that students studying abroad can return to Indonesia. For Indonesia, it is impossible to use expensive experimental equipment such as excellent laser; thus, I chose theory instead. Even now, my joint researcher is in charge of part that needs experiment, while I provide a theory model. (Research Coordinator, Department of Physics, Faculty of Mathematics and Natural Sciences, UI)

Promotion of science and technology in Indonesia

I think that support from the government and university as well as a system to facilitate such assistance would be necessary to improve research in Indonesia. (Research Coordinator, Department of Physics, Faculty of Mathematics and Natural Sciences, UI)

We have valuable assets such as biodiversity in Indonesia. We need special knowledge to utilize those assets effectively and link them to economic development, which can be achieved by joint research, but substantial sharing of information/idea will be required. Japan has been offering us great support and we would like to have more comprehensive, sustainable support. For instance, Japan support programs tend to focus on a specific item like orangutan or orchid, and pull out once they find the target/information they want. However, we have to keep preserving the environment that fosters those items. (Professor, IIS)

② Academic publishing

Incentives for academic writing and evaluation of faculty members

(Bonus and other incentives)

To be acknowledged by research community is one of the incentives to present research outcomes in international academic journals. Money is not the purpose, yet university will pay five million rupiah to each source published in an international journal. DGHE will pay 50 million rupiah per source, but they have conditions (e.g., less than five coauthors) and it is a competitive program; thus, almost one out of ten sources is able to win the bonus. (Professor, Faculty of Mathematics and Natural Science, ITB)

Our scientific society was established in 1985 and currently has nearly 500 members. Like Japanese Society for Plant Systematic, we hold an annual meeting with seminars and subcommittees. We have recently been required from the government to present 16 papers in international academic journals and local magazines. Incentives to researchers engaged in these activities are as follows: Travel expense (transportation and accommodation fee) will be paid when travelling from rural areas; various opinions can be heard concerning their own papers; and a network of researchers can be developed. (Professor, IIS)

(Evaluation of achievement)

Presentation to international journals is especially highly evaluated among academic work. We have a national guideline concerning research evaluation. For example, it sets evaluation criteria by which 20 points are given for presentation to a monograph, 40 for that to an international journal, 25 for that to a domestic journal, and one for that to a newspaper. The university's teaching staff use the evaluation criteria of the Ministry of Education, while research staff use those of the Ministry of Research and Technology. (Professor and Head of Department of Geological Engineering, UGM)

For Indonesia, only a few sources seem to be accepted by international academic journals. I feel that faculty members put priority on their daily life rather than presentation to international journals. There seems to be a case that faculty members are unable to keep up motivation under the research environment in Indonesia, although they bring Japanese-style research methods or themes back to the home country. As far as I know, faculty members do not have high motivations concerning a point system that highly evaluates international academic publishing. (Advisor, DGHE)

International coauthors and advantage

(Coauthors)

I have been engaged in joint research with Dutch and Germans as I have a connection with them since my post doctoral days. Other faculty members have been writing international joint papers with their academic supervisors (e.g., Europeans and Japanese). (Faculty of Mathematics and Natural Science, ITB)

80% of my international coauthors are Japanese and the rest (20%) are researchers who are Russians and Germans and interested in the similar theme. Belarusian scientists have the same interests and we are engaged in joint research (experiment) in Indonesia. The head author of international joint writing is decided depending on the location of experiment. There used to be no researchers engaged in the same field in Indonesia and international coauthorship was necessary accordingly. Now, we have three groups related to my research theme in Indonesia, which all consist of students I taught. (Director, Private Research Institute)

In Indonesia, coauthorship among Indonesian researchers consists of those who belong to a single institute rather than various researchers of multiple institutions. Most universities provide liberal arts and they are not for research; thus, institutions to which researchers belong are limited. Indonesian students who have returned from overseas study tend to be engaged in joint writing with academic supervisors in the recipient countries. We have not yet reached an era of coauthorship among Indonesian institutions. (Director, Center for Science and Technology development Studies, IIS)

(Advantage)

International coauthorship has many advantages. International joint research will allow us to use high-quality facilities of the coauthor institutions, which greatly improves the quality of data. We do not have any trust-based relationship with international academic journals. However, our international joint papers have been easily accepted by them, which means quality comes first, followed by trust. Our joint research partners are researchers of Japan, the U.K., Germany, the U.S., and so on. We started a personal relationship in the beginning,

which then develops to a project. (Professor and Head of Department of Geological Engineering, UGM)

Half of my papers are joint works with my academic supervisors. They have been well known to the research community, which makes it easier to present sources in international journals. My name will be familiar and easier to be accepted as I continue to make achievements. It is obvious that we are lacking in facility in Indonesia; thus, our sources are not accepted or trusted by journals. Furthermore, it is easier for us to purchase chemical agents in overseas. (Faculty of Mathematics and Natural Science, UGM)

③ Academic career path and the highest degree of faculty members

Academic career and return to home country

At ITB, five faculty members of the Department of Mathematics/Natural Science have received a bachelor's degree from ITB, and then doctoral degree from overseas universities (two in Japan and one each in U.S., U.K., and Netherland). Reasons for returning to Indonesia where poor experimental facilities are available are as follows: Family matters, agreement signed before the overseas study and willingness to contribute to the country. (Faculty of Mathematics and Natural Science, ITB)

I got a bachelor's degree in Indonesia, and then master's and doctoral degrees from a Japanese university where I studied with a scholarship from the Ministry of Education, Culture, Sports, Science and Technology Since the acquisition of these degrees, I have been busy in working for various management divisions, organizing international conferences, or advising graduate students; thus, I am personally not engaged in research that much. (Professor, IIS)

To promote return to the home country, each institution has a researcher to be sent abroad sign an agreement . Under the agreement, researchers are required to serve the sending organization for a certain period (usually double the duration of overseas study + one year) after returning home. (Assistant Deputy for National Research Science and Technology Program)

At UGM, three faculty members of the Department of Mathematics/Natural Science have obtained their doctoral degrees overseas (two in Japan and one in Australia). Two of them used to work for a business entity for one to two years after getting a bachelor's degree. Agreement with the sending organization is one of the reasons for their returning to the country after studying aboard. More than that, they felt that they have much responsibility for the country. However, it is necessary for researchers to visit advanced nations for two to three months per year to learn new knowledge because being in Indonesia for a long time would prevent them from keeping up with scientific advances. (Faculty of Mathematics and Natural Science, UGM)

After getting a bachelor's degree from UI, I received a scholarship from the German government and studies at a university in Germany to obtain a doctoral degree in 1991. Subsequently, I got a post doctoral job in the U.S., Germany, and Japan, and then returned to UI. The reason for returning to Indonesia was that there was no "real" research in Indonesia at that time and I thought it is a great challenge to expand research here. Furthermore, I am an average researcher seen from advanced nations including the U.S. and Japan, but I thought that I could be an outstanding researcher in Indonesia and be able to show that

research can be conducted even in Indonesia. (Research Coordinator, Department of Physics, Faculty of Mathematics and Natural Sciences, UI)

I received research guidance concerning my master's degree from a university in Tokyo; took a doctoral degree course in university in Australia; and obtained a doctoral degree from ITB. I am a member of a research team of six faculty members and I am the only person who attained a doctoral course in Indonesia. Indonesia is rich in terms of plant diversity. It is the reason that I decided to stay in Indonesia to research plants, our traditional resources. (Professor, Faculty of Mathematics and Natural Science, ITB)

### Academic degree of faculty members

Legislation to improve quality of teachers took effect in 2005 (i.e., requiring university teaching staff to have a master's or higher degree ). A thousand people have learned in Australia or Japan under the governmental budget so far. It is also said that the salary of faculty members will be doubled starting next year. An average monthly salary of a faculty member is estimated to be around 15,000 yen, which is too small to live on. After incorporation, salary and tuitions will be decided by each. (Advisor, DGHE)

Our department has 35 faculty members and nearly half of them are doctoral degree holders. The younger generation under 40 years old are more likely to have a doctoral degree (Professor and Head of Department of Geological Engineering, UGM)

The faculty members of the Department of Chemistry are more likely to have a doctoral degree than those of the other departments, with 70% of them being doctoral degree holders. This is attributable to a network and atmosphere of the society, where faculty members who have obtained a doctoral degree encourages the next younger generation to obtain one. (Faculty of Mathematics and Natural Science, UGM)

(Reference) For faculty (lecturers) of Indonesian higher education institutes (HEI), the percentage of degree holders was 5.44% in 2003 (i.e., 11,134 out of a total 204,538 lecturers). Source: Indonesian Science and Technology Indicators 2006, Table D. 11 (Source: University Statistics, DGHE, Department of National Education 2003)

### ④ Treatment of faculty

Faculty members of national universities are public employees with a low pay; thus, many of them have a part time job at private universities. I am engaged in theoretical research, which is difficult to show a direct effect on society; thus, my research plan was not approved by the government, which is seeking applied research. I used to cover much of the research at my own expense; however, once UI became sensitive to a college ranking published by The Times and others and acknowledged research as an important index, they have started financial support and now they even cover registration fees to international conferences and have raised salary. In exchange for those support, we are required to present at least one paper in prestigious international academic journals every year. (Research Coordinator, Department of Physics, Faculty of Mathematics and Natural Sciences, UI)

We do not have any secretary or technician and have students do the job instead. Some faculty members, including me, have a part time job in Jakarta to make up for a low salary. (Faculty of Mathematics and Natural Science, ITB)

### ⑤ Challenges for graduate school education and research cooperation/support of Japan

#### Challenge for graduate schools

ITB's graduate school program has both advantage and disadvantage: It is strength to conduct research in the environment close to nature of the home country, while it is weakness that facility is not well organized. Considering the situation, I would think that overseas study under a sandwich program is an effective method for students. (Professor, Faculty of Mathematics and Natural Science, ITB)

I would think that students should get their doctoral degrees in Indonesia. Although they can perform their post doctoral studies abroad, they should obtain a doctoral degree here because it will eventually make them return to the country. If students obtain a degree overseas and return to the country, they will be disappointed at undeveloped facility and turn to be managerial/teaching staff instead of continuing research. Even if a degree is obtained in Indonesia, its quality can be kept to a certain level with proper quality control. I personally assign my students in a doctoral degree course to present their papers to four international academic journals out of 20 specific journals. (Director, Private Research Institute)

(Reference) The number of Indonesian students who obtained a doctoral degree was 408 in 2003 and 644 in 2004. Among them, those majoring in Natural Science & Engineering accounted for 33.6% and 37.9% in 2003 and 2004 respectively. Source: Indonesian Science and Technology Indicators 2006, Table D. 11 (Source: University Statistics, DGHE, Department of National Education 2003)

#### Higher education in Indonesia

I hear that outstanding university graduates tend to concentrate in financial business in metropolitan areas like Jakarta rather than in the country's core industry including manufacturing. Although Indonesia is famous for its rich nature, it relies on imports for some agricultural products, and development of agriculture is a critical issue. Some graduates from the country's top agricultural university, Bogor Agricultural University, get a job in the business sector instead of going into agriculture. This "mismatch" has turned out to be an issue in the government. A level of college graduates is not the same either. (Advisor, DGHE)

#### Research cooperation/support of Japan

Not only rich facility but also the environment in which students can learn attitudes/culture to study is the reason for students to prefer studying at graduate school in Japan to doing so in Indonesia. Scientific knowledge is available on the Internet/books; however, "to be able to understand" and "to be able to put into action" are two different things. In Japan, students can learn not only knowledge but also a problem-solving method and "hard-working" culture. Indonesia is not competitive, thus it is desirable to learn to "compete" in Japan. (Professor, IIS)

I would like Japan to consider a special award program to personnel who conduct basic research in developing countries. A reward for the Humboldt prize in Germany can be used when recipients visit Germany. I would think that developing a system that allows excellent researchers from developing countries to conduct research in Japan will bring mutual benefit

to both countries.[35] (Research Coordinator, Department of Physics, Faculty of Mathematics and Natural Sciences, UI)

Highest level students may go abroad for study, but inviting Japanese faculty members to Indonesia would be more cost-effective than sending Indonesian students overseas. It is most important that students should know that there are various paths to research and they are not necessarily able to go a best (shortest) way. Faculty members in developed countries, especially in their prime, probably do not want to spend time in developing countries but even guidance from retired faculty members is beneficial. (Director, Private Research Institute)

I hear that Japanese universities have more various tasks than before and that it is difficult for young faculty members who have relatively heavy responsibility to go abroad for supporting developing nations. Without any fruits, joint research will not be acknowledged as achievement of faculty members themselves. We have an advantage in the field of nature/environment (e.g., agriculture, fishing, and pharmacology) when conducting research in Indonesia. It should be necessary to solve the imbalanced relationship between Japan and Indonesia such as "Give and take" in order to achieve a sustainable support for higher education. (Advisor, DGHE)

[Results of interviews concerning academic support from Japan to Indonesia]

Selection of students to study in Japan

We do not put any priority on a specific field of study in selecting students to study in Japan at national expense, but we see many applicants in natural science fields at graduate school. For humanities and social sciences, many students go to Japan in order to learn Japan including Japanese language. We used to select public employees with a view to develop university faculty and government officers, but now we remove the restriction and even undergraduate students are allowed to apply. Conditions for studying in Japan at national expense are as follows: ages 35 or younger and a GPA score of 3.0 or more (where 4.0 is at the highest score). (First secretary, Japanese Embassy in Indonesia)

Support from Japan to Indonesian students studying in Japan and its challenges

The number of Indonesian students going to Japan for study is very limited and it we should increase this number. There are some rich people who can study abroad at their own expense, but there is a lack of information on studying in Japan and no agencies to offer services concerning studying in Japan in Indonesia. These are reasons for the small number of Indonesian students studying in Japan. (First secretary, Japanese Embassy in Indonesia)

Travelling to Japan for study was mainly backed up by Japanese expense and focused on graduate school, while the number of undergraduate students studying in Japan at their own expense is limited. Those are the characteristics and issues of supports from Japan. People in the upper class and in the metropolitan areas are able to study abroad at their own expense; however, most of them go to English-speaking countries such as Australia and Malaysia, which are geographically close to Indonesia instead of Japan. It is our next challenge to

[35] The Humboldt Research Award is granted by the Alexander von Humboldt Foundation, an organization fully financed by the German government and supporting international academic activities. The reward is offered to a maximum of 100 excellent foreign researchers every year. Recipients of the reward are allowed to conduct research at institutes they choose in Germany using prize money.

address the issue. Japanese universities are not as good at advertising as Western universities, which go in a businesslike manner. (Advisor, DGHE)

### Japan's educational support for Indonesia

Support of Japan (JICA) aims to develop bachelor-level personnel in industrial areas to have them learn practical skills focusing on the field of Engineering. Currently, they have been implementing a project to develop human resources at ITS (Institut Teknologi Sepuluh Nopember) through education at research laboratory and joint research. We hold a video conference with universities in East Indonesia and cooperate with Japanese universities as well. JICA supported exchange between academia and the business community until this March at UGM, which was a project to promote cooperation with the business sector as well as advice to local community as part of social contribution by university faculty. (Advisor, DGHE)

# 6. Summary of the results and discussion

In this survey, we have attempted to have a quantitative understanding of the research results of developing countries, which used to attract little attention, with a focus on international coauthorship based on the Thomson Reuter Scientific's data considering scholarly papers. As a major result, first, we have confirmed that sources written in low-income countries and Sub-Saharan Africa accounts for is as small as 1% of the total number of sources worldwide, and the share has been declining further, although the number of sources are increasing globally. This is considered as an indication of the divergence between low-income countries/Sub-Saharan Africa and high-income nations or other regions in terms of intellectual activities represented by scholarly papers. Second, according to the analysis on the international coauthorship rate, it has been confirmed that this rate grew for 10 years since 1998 and varied by region. The regional variance seems to be related to the relationship between the international coauthorship rate and the developmental level of academic publishing (i.e., When the international coauthorship rate is high in a country, its research activities are small in scale).

We have selected six developing countries and analyzed their international coauthorship. As a result, it has been confirmed that the international coauthorship rate is high while the ownership rate is low if the number of sources is small. For those six countries, the U.S., Japan, the U.K., and Germany were found to be the key coauthors. It has been confirmed that the U.S. is more likely to play a leading role in joint academic publishing with all six nations, while Japan is more likely to do so in joint publishing with two Southeast Asian countries. It is one of the options for Japan to continue to play this role in these two countries in a more advanced manner if it wants to sustain and expand an international network of researchers. It is expected that Japan will have many joint papers with those developing countries (i.e., between foreign students who have obtained doctoral degree in Japan and returned to their home countries and Japanese academic supervisors). Therefore, what Japan should do to support them is to increase the number of foreign students who study in natural science doctoral courses, provide training that considers their return to home countries, and support their research in their home countries.

A mid-term report submitted by Council for Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology in December 2009 proposes that the government should promote strategic acquisition of high-level foreign students based on the "300,000 Foreign Students Plan," and enhance efforts such as an invitation program that allows foreign students to re-visit Japan and support to finance research expenses. Measures in accordance with those proposals should be considered accordingly. However, it is a primal requirement to support the provision of academic guidance and the research environment in a way that allows foreign students to continue research independently after returning to their home countries. The career path of foreign students is diversified, with some of them getting a job in Japan. In Japan, university faculty in natural sciences are required to present outcomes based on leading-edge research; thus, it may not be easy to provide research guidance that enables foreign students from developing countries to continue research after returning to their home countries. Nonetheless, a guidance based on a long-term perspective would be necessary to expand international academic research networks.

International presentation of scholarly papers is highly evaluated as achievement in the two target Southeast Asian countries, and they have a system to motivate researchers to present their work internationally, but whether the system is effectively utilized has yet to be fully studied. However, it is unlikely that such an environment that connects the motivation system to

macroscopic expansion of sources has been developed, considering a large number of issues concerning research environment such as the small number of researchers and research supervisors, an environment preventing faculty from focusing on research [small salary and heavy teaching responsibility] and poor experimental facilities. Therefore, if the Japanese government plans to increase the number of foreign students studying in a doctoral courses in Japan or offer assistance to researchers of developing countries, it should prepare an appropriate research environment for motivated researchers of developing countries, with attention to insufficient treatment of university faculty in each target country.

There are a wide range of advanced issues that should be addressed in the future as an extension of this survey. First, it would be necessary to identify factors that will have a great impact on the level of and change in the number of sources (i.e., development of a model to convert the number of sources to explained variables and quantitative analysis of this model) and analysis for the purpose of searching factors affecting the selection of coauthor countries, since the analysis on this survey is limited to understanding the actual status. We have selected two Southeast Asian countries that are geographically close to Japan and have received large amounts of academic assistance from Japan, and conducted a case study of them. In this regard, future studies should include other countries with different conditions in the target and conduct a survey of their research environment.

A challenging, advanced theme for the future is to shift from analysis on academic publishing as a product (output) of research activity to analysis that incorporates perspectives on contribution to local people (outcome). We have focused on the “number” of sources in this survey; however, it is not clear, for example, how much the increase in the number of sources in the field of agriculture in a developing country has “contributed” to the improvement of the living standards of local people through improved agricultural production. It is critical to conduct further analysis on such themes because developing countries need to utilize their limited research resources for the development of their own countries.

## Acknowledgement

We would like to extend our sincere gratitude to all the people who have contributed to this survey. We are particularly grateful for the interviewees in Japan, the Philippines, and Indonesia who have kindly spent their valuable time for our long interviews . We also would like to thank Ms. Keiko Ito, Ms. Moe Akimichi, and Mr. Masamichi Matsuda for their cooperation in data analysis. We would like to express our deep and sincere gratitude to all of them.

## Assignment of research work

(Organizer: National Institute of Science and Technology Policy, 1st Policy-Oriented Research Group)

| | |
|---|---|
| Research planner | : Maki Kato |
| Research method planner | : Maki Kato |
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## Abbreviation

| | |
|---|---|
| AUN/SEED-Net: | Southeast Asia Engineering Education Development Network (Network of development of higher education in the field of Engineering in ASEAN) |
| CHED: | Commission on Higher Education (Higher education agency in Philippines) |
| DGHE: | Director General of Higher Education |
| DLSU: | De La Salle University |
| ERDT: | Engineering Research & Development for Technology Consortium |
| IIS: | Indonesian Institute of Science |
| ITB: | Institute Technology Bandung |
| JICA: | Japan International Cooperation Agency |
| UI: | University Indonesia |
| UP: | University of Philippines |
| UGM: | Gadjah Mada University |

# (Reference)　Reference of the six target countries of case study

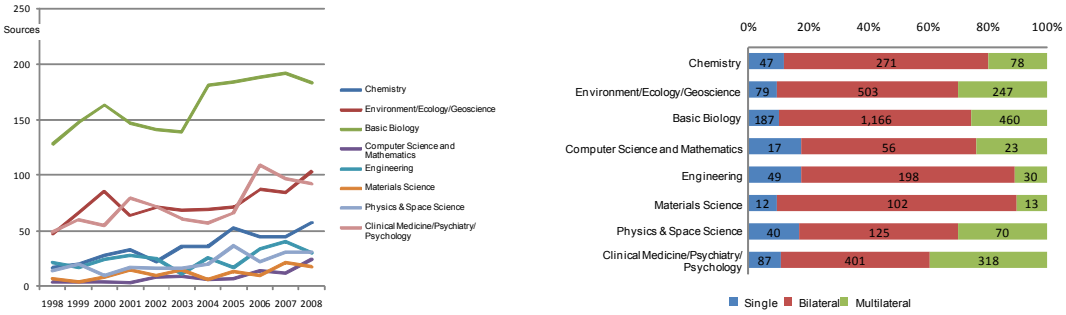
## Indonesia

1. Movements in the number of sources and the international coauthorship rate by category

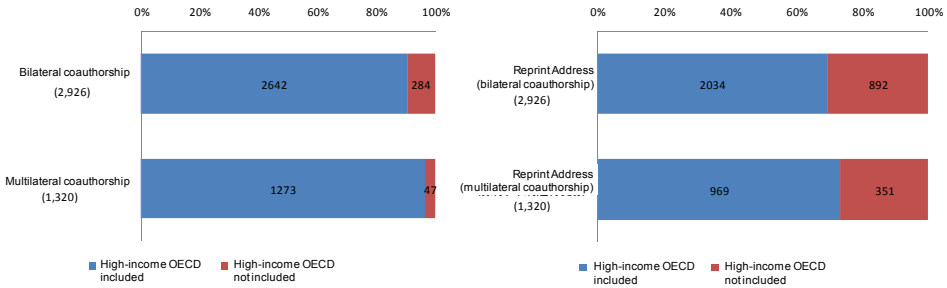
Reference Table/Chart 1 shows movements in the number of sources by subject category between 1998 and 2008. No category indicates an outstanding increase/decrease during the period. Each category shows that the percentage of sources written by a single country is small, and that of bilateral and multilateral coauthorship is large (with bilateral coauthorship having a predominant share).

Reference Table/Chart 2 shows the percentage of engagement of high-income OECD nations in international coauthorship. More than 90% of the international papers include authors in institutions in high-income OECD nations, and nearly 70% or more reprint addresses include institutions in high-income OECD nations.

Reference Table/Chart 1　Number of sources by category (Left: Movements in the number of sources, Right: Breakdown by the number of coauthor countries)




Reference Table/Chart 2　Percentage of engagement of high-income OECD nations in academic publishing (Left: Number of sources, Right: Reprint address)




2. Characteristics of institutions engaged in academic publishing

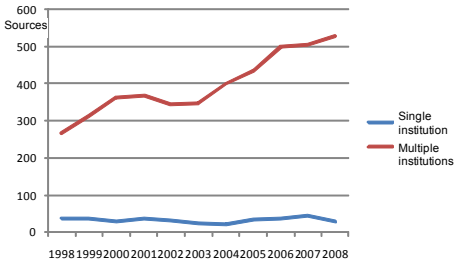
Reference Table/Chart 3 indicates the top 10 institutions in the number of Indonesian sources produced. Indonesian universities/institutions constitute the top five, followed by USN (United States Navy) and Japanese universities (University of Tokyo and Kyoto University) and others.

Reference Table/Chart 3　List of institutions engaged in academic publishing (Top10)

| | Official name in English (Abbreviations/original name) | Sources | Ratio | Country |
|---|---|---|---|---|
| 1 | University of Indonesia (Universitas Indonesia) | 474 | 9.9% | Indonesia |
| 2 | Bandung Institute of Technology (Institut Teknologi Bandung or ITB) | 310 | 6.5% | Indonesia |
| 3 | Gadjah Mada University (Universitas Gadjah Mada or UGM) | 281 | 5.9% | Indonesia |
| 4 | Bogor Agricultural University (Institut Pertanian Bogor or IPB) | 274 | 5.7% | Indonesia |
| 5 | Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia or LIPI) | 212 | 4.4% | Indonesia |
| 6 | United States Navy | 155 | 3.2% | United States |
| 7 | University of Tokyo | 150 | 3.1% | Japan |
| 8 | Kyoto university | 128 | 2.7% | Japan |
| 9 | University of Western Australia (UWA) | 105 | 2.2% | Australia |
| 10 | Airlangga University (Universitas Airlangga or UNAIR) | 102 | 2.1% | Indonesia |

Indonesian sources written by multiple institutions are much larger in number than those published by single institution (university or research institute in Indonesia) (i.e., 30 and 529 sources were published by single and multiple institutions, respectively, in 2008). The number of sources written by multiple institutions increased between 1998 and 2008, while that of sources published by a single institution remained sluggish (Reference Table/Chart 4).

Reference Table/Chart 4　Movements in the number of sources (by institution)




Reference Table/Chart 5 shows the combinations of coauthor institutions, by dividing coauthors into two types: universities and non-university institutions. Both sources coauthored by institutions in Indonesia and those internationally coauthored involve only a single Indonesian university/institution as a coauthor.

Reference Table/Chart 5　Coauthorship among institutions in Indonesia

| University / Non-university institution | Sources written by single nation | | | | | Sources of international coauthorship | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | Multilateral | Total | 0 | 1 | 2 | Multilateral | Total |
| 0 | 0 | 172 | 15 | 4 | 191 | 0 | 1,738 | 61 | 4 | 1,803 |
| 1 | 197 | 73 | 7 | 0 | 277 | 1,870 | 199 | 14 | 4 | 2,087 |
| 2 | 40 | 12 | 0 | 1 | 53 | 211 | 51 | 11 | 2 | 275 |
| Multilateral | 12 | 5 | 0 | 0 | 17 | 61 | 18 | 2 | 0 | 81 |
| Total | 249 | 262 | 22 | 5 | 538 | 2,142 | 2,006 | 88 | 10 | 4,246 |

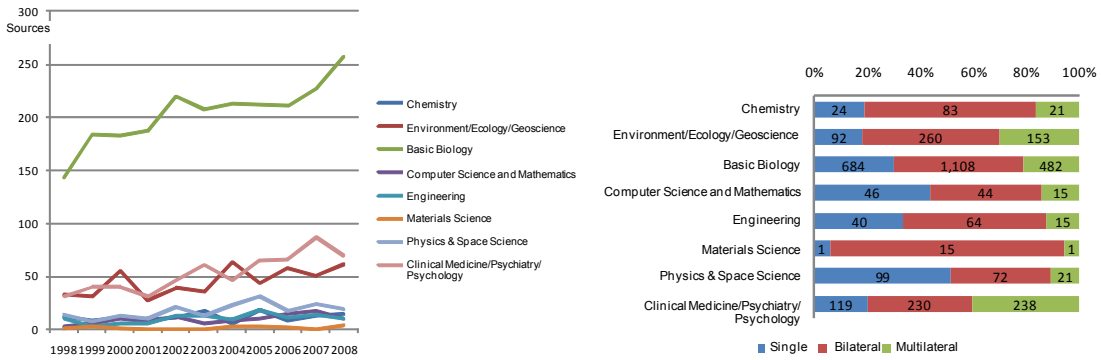
## Philippines

1. Movements in the number of sources and the international coauthorship rate by category

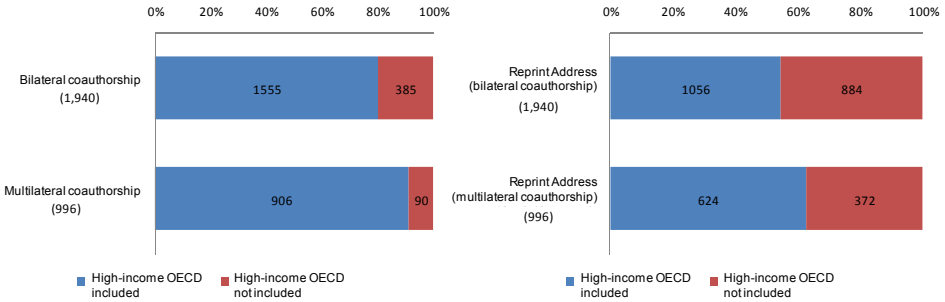
A large number of academic papers were published in the field of Basic Biology between 1998 and 2008, and the rate of growth in the number of sources was high in this field over the same period. The international coauthorship rate varies depending on field. With regard to Physics & Space Science and Computer Science & Mathematics, the percentage of sources written by single nation accounts for more than 40% (Reference Table/Chart 6).

A percentage of involvement of high-income OECD nations with bilateral and multilateral publishing in the Philippines accounts for about 80% and 90%, respectively. High-income OECD nations account for 57.2% of the reprint addresses of international joint papers (Reference Table/Chart 7).

Reference Table/Chart 6 Number of sources by category (Left: Movements in the number of sources, Right: Breakdown by the number of coauthor countries)




Reference Table/Chart 7 Percentage of engagement of high-income OECD nations in academic publishing (Left: Number of sources, Right: Reprint address)




2. Characteristics of institutions engaged in academic publishing

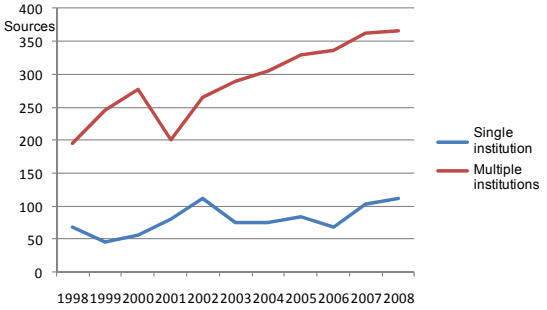
A list of top 10 institutions in the number of sources is shown in Reference Table/Chart 8. Six Philippine universities/institutes are included here in addition to two Japanese universities (University of Tokyo and Osaka University). The list indicates that the University of the Philippines is involved in more than one-third (about 35%) of the overall sources.

Reference Table/Chart 8　List of institutions engaged in academic publishing (Top10)

| | Official name in English (Abbreviations/original name) | Sources | Ratio | Country |
|---|---|---|---|---|
| 1 | University of the Philippines(include UP Los Baños) | 1445 | 35.0% | Philippines |
| 2 | International Rice Research Institute (IRRI) | 920 | 22.3% | Philippines |
| 3 | Southeast Asian Fisheries Development Center (SEAFDEC/AQD) an intergovernmental organization. the Secretariat is based in Bangkok, Thailand. | 187 | 4.5% | South East Asia (Thailand) |
| 4 | De La Salle University | 122 | 3.0% | Philippines |
| 5 | Research Institute for Tropical Medicine (RITM) | 106 | 2.6% | Philippines |
| 6 | University of Tokyo | 79 | 1.9% | Japan |
| 7 | WHO Philippines | 74 | 1.8% | Philippines |
| 8 | Osaka university | 67 | 1.6% | Japan |
| 9 | University of Santo Tomas | 66 | 1.6% | Philippines |
| 10 | University of Utah | 61 | 1.5% | United States |

The number of papers written by multiple institutions was always larger than that of papers published by a single institute between 1998 and 2008, and declined sharply between 2000 and 2001. Thereafter, the number increased monotonously. In the meantime, the number of academic publishing by a single institute grew between 1998 and 2002, which then kept almost the same level while experiencing rises and drops repeatedly (Reference Table/Chart 9).

Reference Table/Chart 9　Movements in the number of sources (by institution)




With regard to both sources written by a single nation (Philippines) and those written by international coauthorship between multiple countries, sources involving a single university from the Philippines account for the largest part, followed those involving a single institute from the Philippines (Reference Table/Chart 10).

Reference Table/Chart 10　Coauthorship among institutions in the Philippines

| University / Non-university institution | Sources written by single nation | | | | | Sources of international coauthorship | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | Multilateral | Total | 0 | 1 | 2 | Multilateral | Total |
| 0 | 0 | 585 | 60 | 2 | 647 | 0 | 1,512 | 113 | 19 | 1,644 |
| 1 | 311 | 107 | 5 | 1 | 424 | 1,082 | 139 | 8 | 0 | 1,229 |
| 2 | 53 | 27 | 1 | 0 | 81 | 23 | 25 | 4 | 0 | 52 |
| Multilateral | 2 | 5 | 5 | 1 | 13 | 2 | 8 | 1 | 0 | 11 |
| Total | 366 | 724 | 71 | 4 | 1,165 | 1,107 | 1,684 | 126 | 19 | 2,936 |

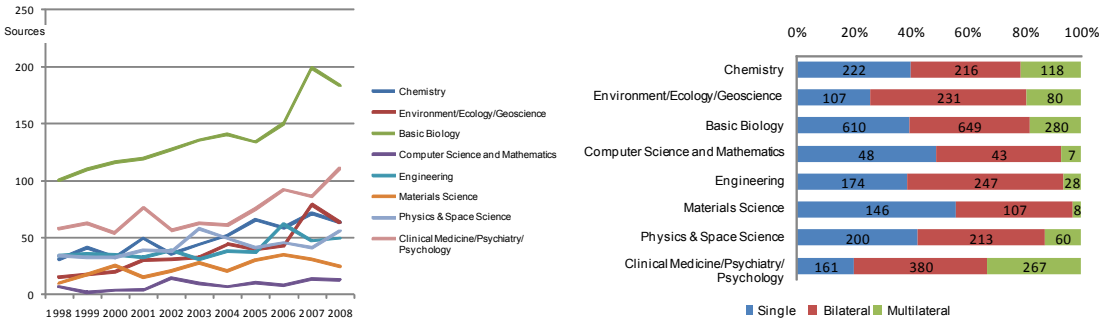
## Bangladesh

1. Movements in the number of sources and the international coauthorship rate by category

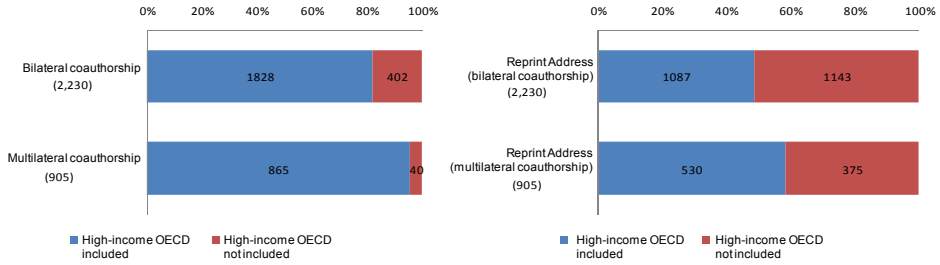
The number of sources in the fields of Basic Biology and Environment/Ecology & Geosciences was on increase between 1998 and 2008. The breakdown of sources by the number of international coauthors countries vary depending on the field. The share of sources published by a single nation is less than 20% in the fields of Environment/Ecology & Geosciences and Clinical medicine/Psychiatry/Psychology (Reference Table/Chart 11).

The percentage of involvement of high-income OECD nations in bilateral and multilateral publishing in Bangladesh is 80.2% and 95.6%, respectively. High-income OECD nations account for about 50% to 60% of the reprint addresses of international joint papers (Reference Table/Chart 12).

Reference Table/Chart 11 Number of sources by category (Left: Movements in the number of sources, Right: Breakdown by the number of coauthor countries)




Reference Table/Chart 12 Percentage of engagement of high-income OECD nations in academic publishing (Left: Number of sources, Right: Reprint address)




2. Characteristics of institutions engaged in academic publishing

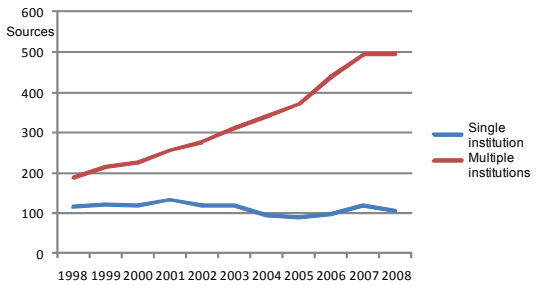
The following list of the top 10 institutes in the number of sources includes seven universities and two institutes of Bangladesh. Johns Hopkins University (U.S.) ranks ninth (Reference Table/Chart 13).

Reference Table/Chart 13　List of institutions engaged in academic publishing (Top10)

| | Official name in English (Abbreviations/original name) | Sources | Ratio | Country |
|---|---|---|---|---|
| 1 | University of Dhaka (DU, Đhaka Bishshobiddalôe) | 776 | 15.9% | Bangladesh |
| 2 | International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B) | 698 | 14.3% | Bangladesh |
| 3 | Rajshahi University (Rajshahi Vishwavidyaalay) | 472 | 9.6% | Bangladesh |
| 4 | Bangladesh University of Engineering and Technology (BUET, Bangladesh Prokoushol Bishshobiddalôe) | 461 | 9.4% | Bangladesh |
| 5 | Jahangirnagar University (Jaha$_0$girnôgor Bishshobiddalôe) | 372 | 7.6% | Bangladesh |
| 6 | Bangladesh Agricultural University (BAU) | 326 | 6.7% | Bangladesh |
| 7 | University of Chittagong (Chôṭṭogram Bishshobiddalôe) | 172 | 3.5% | Bangladesh |
| 8 | Bangladesh Atomic Energy Commission (BAEC) | 138 | 2.8% | Bangladesh |
| 9 | Johns Hopkins University (JHU) | 100 | 2.0% | United States |
| 10 | Shahjalal University of Science and Technology (SUST) | 86 | 1.8% | Bangladesh |

The number of sources written by multiple institutions constantly remained above that of sources published by a single institute and rapidly increased until 2007 (the number increased about 2.5 times between the first and last year of the growth period). In the meantime, the number of sources written by a single institute remains sluggish during the period (Reference Table/Chart 14).

Reference Table/Chart 14　Movements in the number of sources (by institution)




Scholarly papers published by a single nation (Bangladesh) are mainly written by university alone (i.e., 960 papers were written by universities alone, while 499 were published by non-university institutes alone during the target period). With regard to international joint papers, the ratio of papers written by universities alone is almost the same as that of papers written by non-university institutes alone (i.e., 1,599 and 1,388 papers, respectively). Universities as well as non-university institutes tend to publish papers by a single organization (Reference Table/Chart 15).

Reference Table/Chart 15　Coauthorship among institutions in Bangladesh

| University / Non-university institution | Sources written by single nation | | | | | Sources of international coauthorship | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | Multilateral | Total | 0 | 1 | 2 | Multilateral | Total |
| 0 | 0 | 853 | 99 | 8 | 960 | 0 | 1,464 | 80 | 15 | 1,559 |
| 1 | 400 | 228 | 30 | 0 | 658 | 1,184 | 142 | 12 | 1 | 1,339 |
| 2 | 64 | 34 | 4 | 0 | 102 | 157 | 26 | 1 | 0 | 184 |
| Multilateral | 35 | 3 | 0 | 0 | 38 | 47 | 6 | 0 | 0 | 53 |
| Total | 499 | 1,118 | 133 | 8 | 1,758 | 1,388 | 1,638 | 93 | 16 | 3,135 |

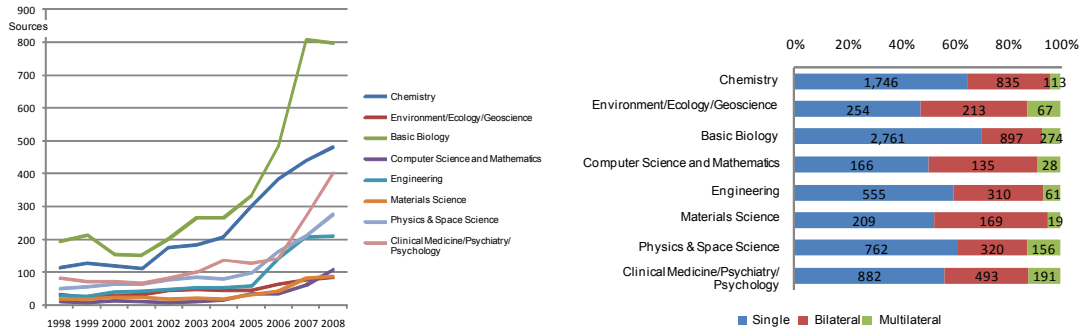
## Pakistan

1. Movements in the number of sources and the international coauthorship rate by category

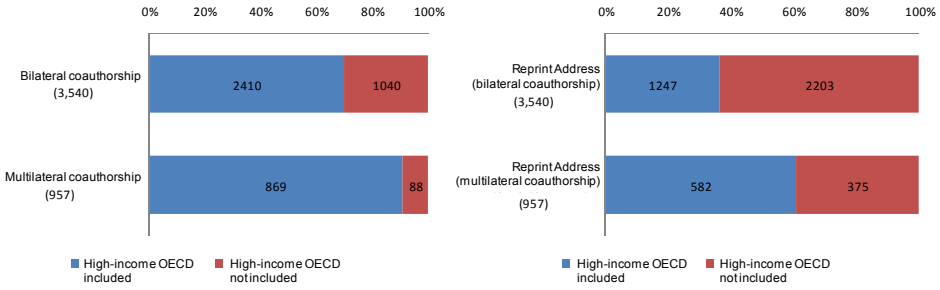
The number of sources in some fields grew rapidly between 1998 and 2008; the trend is particularly notable in Basic Biology and Chemistry. More than half of the sources in almost every field were written by a single nation (Pakistan) and only a small number of papers were published by multiple nations (Reference Table/Chart 16).

The percentage of involvement of institutions in high-income OECD nations in bilateral and multilateral publishing in Pakistan accounts for about 70% (69.9%, exactly) and 90% (90.8%, exactly), respectively. With regard to the reprint address, high-income OECD nations account for 36.1% of the bilateral sources and almost 60% (60.8%, exactly) of the multilateral sources (Reference Table/Chart 17).

Reference Table/Chart 16 Number of sources by category (Left: Movements in the number of sources, Right: Breakdown by the number of coauthor countries)




Reference Table/Chart 17 Percentage of engagement of high-income OECD nations in academic publishing (Left: Number of sources, Right: Reprint address)




2. Characteristics of institutions engaged in academic publishing

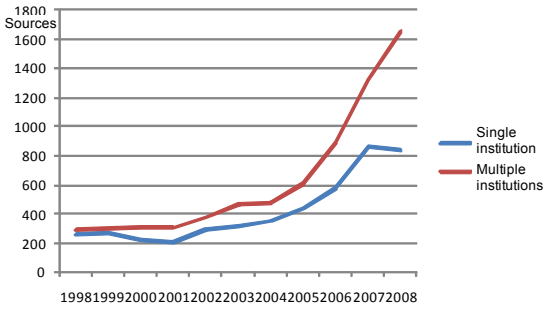
Pakistani universities or institutes constitute the top 10 in the number of sources shown in the following list. The Top two universities are engaged in more than 15% of the overall sources (Reference Table/Chart 18).

Reference Table/Chart 18　List of institutions engaged in academic publishing (Top10)

| | Official name in English (Abbreviations/original name) | Sources | Ratio | Country |
|---|---|---|---|---|
| 1 | Quaid-i-Azam University | 1941 | 16.4% | Pakistan |
| 2 | University of Karachi | 1799 | 15.2% | Pakistan |
| 3 | Aga Khan University (AKU) include Aga Khan University Hospital (AKUH) | 1105 | 9.3% | Pakistan |
| 4 | Pakistan Institute of Science and Technology (PINSTECH) | 816 | 6.9% | Pakistan |
| 5 | University of Agriculture Faisalabad | 774 | 6.5% | Pakistan |
| 6 | University of the Punjab | 626 | 5.3% | Pakistan |
| 7 | University of Peshawar | 442 | 3.7% | Pakistan |
| 8 | University of Sindh | 284 | 2.4% | Pakistan |
| 9 | Bahauddin Zakariya University | 258 | 2.2% | Pakistan |
| 10 | COMSATS Institute of Information Technology (CIIT) | 238 | 2.0% | Pakistan |

The number of sources increased regardless the number of institutions involved until 2007. The number of academic papers written by a single institute kept rising until 2007 like those of multiple institutes but became sluggish between 2007 and 2008, while the number of those written by multiple institutes maintained a rapid increase (Reference Table/Chart 19).

Reference Table/Chart 19　Movements in the number of sources (by institution)




With regard to both sources written by a single nation (Pakistan) and those written by international coauthorship between multiple countries, sources involving a single university or institution account for a largest part. A comparison between sources published by universities alone and those by non-university institutes alone indicates that the former is more than two times larger in number than the latter (Reference Table/Chart 20).

Reference Table/Chart 20　Coauthorship among institutions in Pakistan

| University / Non-university institution | Sources written by single nation | | | | | Sources of international coauthorship | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | Multilateral | Total | 0 | 1 | 2 | Multilateral | Total |
| 0 | 0 | 3,268 | 630 | 106 | 4,004 | 0 | 2,420 | 197 | 32 | 2,649 |
| 1 | 1,454 | 1,063 | 166 | 26 | 2,709 | 1,212 | 285 | 40 | 5 | 1,542 |
| 2 | 355 | 188 | 17 | 4 | 564 | 135 | 42 | 6 | 0 | 183 |
| Multilateral | 100 | 33 | 1 | 0 | 134 | 30 | 3 | 0 | 0 | 33 |
| Total | 1,909 | 4,552 | 814 | 136 | 7,411 | 1,377 | 2,750 | 243 | 37 | 4,407 |

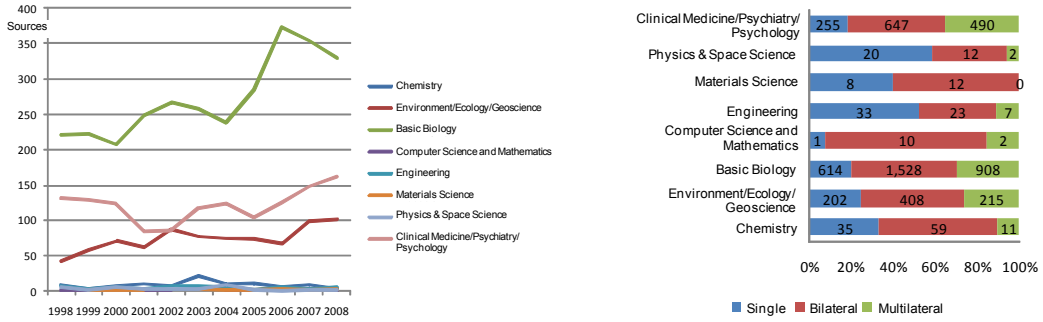
## Kenya

1. Movements in the number of sources and the international coauthorship rate by category

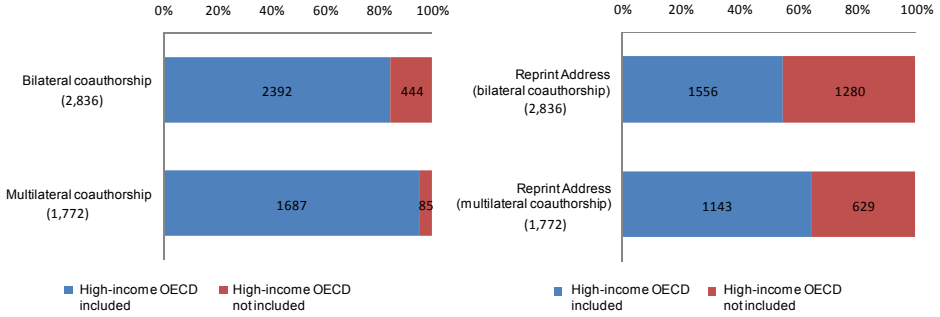
The number of sources in the fields of Basic Biology and Environment/Ecology/Geosciences grew between 1998 and 2008. With regard to Computer Science and Mathematics, whose number of sources is extremely small at 13, the percentage of international joint papers (especially written by two or more countries) was rather high during the same period (Reference Table/Chart 21).

The percentage of involvement of high-income OECD nations with bilateral and multilateral publishing in Kenya accounts for 84.4% and 95.2%, respectively. With regard to the reprint address, high-income OECD nations account for 54.9% of the bilateral sources and 64.5% of the multilateral sources (Reference Table/Chart 22).

Reference Table/Chart 21 Number of sources by category (Left: Movements in the number of sources, Right: Breakdown by the number of coauthor countries)




Reference Table/Chart 22 Percentage of engagement of high-income OECD nations in academic publishing (Left: Number of sources, Right: Reprint address)




2. Characteristics of institutions engaged in academic publishing

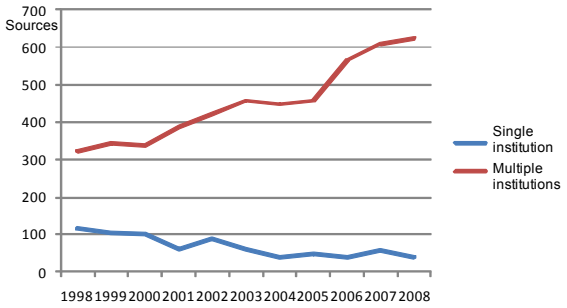
Eight Kenyan universities/institutions are included in the following top 10 list in the number of sources. The University of Oxford (U.K) ranks sixth. The University of Nairobi has the largest number of sources and is engaged in academic writing of some 20% of the overall papers (Reference Table/Chart 23).

Reference Table/Chart 23 List of institutions engaged in academic publishing (Top10)

| | Official name in English (Abbreviations/original name) | Sources | Ratio | Country |
|---|---|---|---|---|
| 1 | University of Nairobi | 1222 | 20.8% | Kenya |
| 2 | Kenya Medical Research Institute (KEMRI) | 623 | 10.6% | Kenya |
| 3 | The International Livestock Research Institute (ILRI) | 416 | 7.1% | Kenya |
| 4 | International Centre of Insect Physiology and Ecology (icipe) | 369 | 6.3% | Kenya |
| 5 | Kenyatta University | 294 | 5.0% | Kenya |
| 6 | University of Oxford | 290 | 4.9% | United Kingdom |
| 7 | Moi University | 280 | 4.8% | Kenya |
| 8 | Egerton University | 256 | 4.4% | Kenya |
| 9 | National Museums of Kenya (NMK) | 235 | 4.0% | Kenya |
| 10 | Center for Disease Control and Prevention | 225 | 3.8% | United States |

The number of sources produced by multiple institutions increased monotonously while the number of those written by a single institute declined, which shows a widening gap (i.e., the roughly threefold gap in 1998 widened to be about 12-fold in 2008) (Reference Table/Chart 24).

Reference Table/Chart 24 Movements in the number of sources (by institution)




With regard to sources published by a single nation (Kenya), there is no big difference between the number of papers written by universities alone or non-university institutes alone. In the meantime, international joint papers indicate that the number of sources published by non-university institutes alone is about 3.2 times larger than that of sources produced by universities alone; thus, it is considered that non-university institutes are more often engaged in international coauthorship (Reference Table/Chart 25).

Reference Table/Chart 25 Coauthorship among institutions in Kenya

| University / Non-university institution | Sources written by single nation | | | | | Sources of international coauthorship | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | Multilateral | Total | 0 | 1 | 2 | Multilateral | Total |
| 0 | 0 | 436 | 54 | 4 | 494 | 0 | 952 | 29 | 0 | 981 |
| 1 | 378 | 169 | 19 | 3 | 569 | 2,589 | 378 | 10 | 2 | 2,979 |
| 2 | 85 | 60 | 7 | 0 | 152 | 433 | 84 | 13 | 2 | 532 |
| Multilateral | 22 | 9 | 0 | 0 | 31 | 94 | 20 | 2 | 0 | 116 |
| Total | 485 | 674 | 80 | 7 | 1,246 | 3,116 | 1,434 | 54 | 4 | 4,608 |

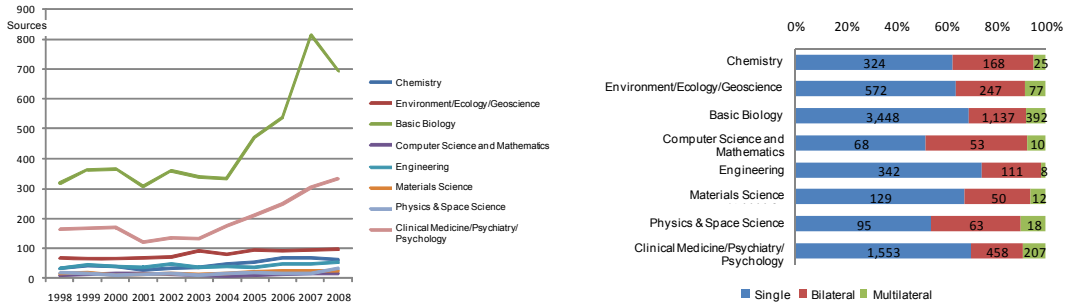
## Nigeria

1. Movements in the number of sources and the international coauthorship rate by category

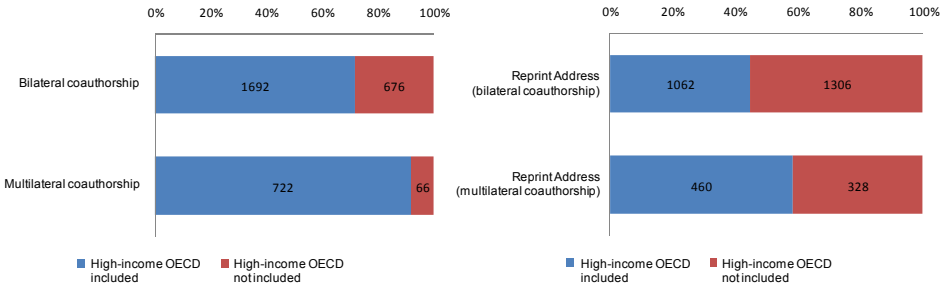
The number of sources shows a rapid increase in the field of Basic Biology after 2004 and Clinical Medicine after 2003 among eight fields. More than half of the sources in all the fields were published by a single nation (Reference Table/Chart 26).

The percentage of involvement of institutions that belong to high-income OECD nations in bilateral and multilateral publishing is some 71.5% and 91.6%, respectively. With regard to the reprint address, high-income OECD nations account for 44.9% of the bilateral sources and 58.4% of the multilateral sources (Reference Table/Chart 27 ).

Reference Table/Chart 26 Number of sources by category (Left: Movements in the number of sources, Right: Breakdown by the number of coauthor countries)




Reference Table/Chart 27 Percentage of engagement of high-income OECD nations in academic publishing (Left: Number of sources, Right: Reprint address)




2. Characteristics of institutions engaged in academic publishing

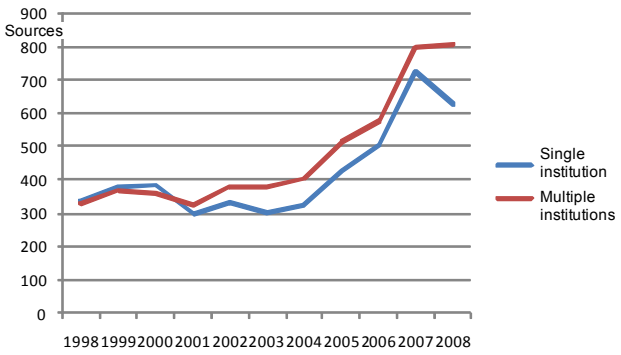
Nigerian universities/institutes constitute the top 10 institutions in the number of sources in the following list. The top two universities show a particularly high percentage and are engaged in the production of about 15% and 10% of the overall sources, respectively (Reference Table/Chart 28).

Reference Table/Chart 28　List of institutions engaged in academic publishing (Top10)

| | Official name in English (Abbreviations/original name) | Sources | Ratio | Country |
|---|---|---|---|---|
| 1 | University of Ibadan | 1526 | 15.1% | Nigeria |
| 2 | Obafemi Awolowo University (OAU) | 1034 | 10.2% | Nigeria |
| 3 | University of Nigeria, Nsukka (NUU) | 761 | 7.5% | Nigeria |
| 4 | Ahmadu Bello University | 713 | 7.1% | Nigeria |
| 5 | University of Lagos | 546 | 5.4% | Nigeria |
| 6 | University of Benin | 541 | 5.4% | Nigeria |
| 7 | University of Agriculture (Abeokuta, Makurdi, Umudike) | 492 | 4.9% | Nigeria |
| 8 | International Institute of Tropical Agriculture (IITA), Nigeria | 485 | 4.8% | Nigeria |
| 9 | University of Ilorin | 331 | 3.3% | Nigeria |
| 10 | University of Calabar (Unical) | 317 | 3.1% | Nigeria |

The number of sources increased between 2001 and 2007 regardless of the number of institutions involved, and no big difference by this number was identified either. In the meantime, the number of sources published by a single institute declined and that of sources published by multiple organizations remained sluggish since 2007, which expanded the gap between them (Reference Table/Chart 29).

Reference Table/Chart 29　Movements in the number of sources (by institution)




With regard to sources published by a single nation (Nigeria) and international joint papers, most of them were written by a single university or institute. A comparison between sources written by universities and those by non-university institutes shows that as to Nigeria alone, the number of papers published by universities is more than 10 times that of papers published by non-university institutes. Likewise, regarding international coauthorship, the former is nearly 3.5 times that of the latter (Reference Table/Chart 30).

Reference Table/Chart 30　Coauthorship among institutions in Nigeria

| University / Non-university institution | Sources written by single nation | | | | | Sources of international coauthorship | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | Multilateral | Total | 0 | 1 | 2 | Multilateral | Total |
| 0 | 0 | 4,309 | 994 | 129 | 5,432 | 0 | 1,949 | 218 | 41 | 2,208 |
| 1 | 446 | 737 | 127 | 23 | 1,333 | 583 | 233 | 37 | 2 | 855 |
| 2 | 44 | 58 | 13 | 8 | 123 | 45 | 23 | 11 | 1 | 80 |
| Multilateral | 7 | 14 | 5 | 1 | 27 | 8 | 5 | 0 | 0 | 13 |
| Total | 497 | 5,118 | 1,139 | 161 | 6,915 | 636 | 2,210 | 266 | 44 | 3,156 |