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AN EXPLORATORY APPROACH TO KOREAN AND CHINESE INTERNATIONAL R&D COOPERATION: A GOVERNMENT PERSPECTIVE

Abstract:

In recent times, the rise in technological convergence has been accompanied by a global increase in joint research efforts to outsource technology and R&D support. While global S&T joint research has mostly been centralized in the US and EU, such activities amongst Asian countries are nearly non-existent. In this setting, Korea and China have pursued international joint research efforts following the Korea-China Science and technology Cooperation Agreement signed in 1992. This paper will examine the current state of international cooperative research in Korea and China, and draw up several conclusions on their relationship as well as future recommendations for consideration.

Keywords:

international S&T cooperation, Korea-China, international joint research projects

JEL Classification: L38

1 Introduction

Presently, the world is witnessing fierce competition surrounding the development of cutting-edge technology, making the formation of international partnerships an increasingly crucial means of outsourcing. Indeed, international S&T cooperation is expanding on a global scale (Wilsdon et al., 2011).

International science and technology cooperation research has been carried out mainly on international R&D projects in the US and EU. Meanwhile, though the total economic output from Korea, China, and Japan sum to over 20% of world GDP, Asian countries have yet to match this contribution in R&D productivity and have not taken on a definitive, autonomous role in global S&T governance. In the case of South Korea, technological catch-up by China and developing countries have made it no longer possible to maintain its competitiveness in the world market through imitative practices. Continued technological convergence will instead require more diverse knowledge, particularly from procuring international R&D resources that can compete in a global arena.

One opportunity to nurture international cooperative S&T activity within Asia emerged with the explosive development in China. Multinational companies scrambled to launch research institutions that could access educated, high quality Chinese labor, effectively pioneering the maturation of the newly opened market. Such trends also have their effects on the path of S&T cooperation between Korea and China.

Following the Korea-China S&T Cooperation Agreement signed in 1992, the two nations have seen 25 years of collaboration. This paper will examine the current state of their relationship, and draw up several conclusions as well as future developmental recommendations for consideration.

2 Literature on the Internationalization of R&D Cooperation

Much of academic literature on international R&D initially focused on technological applications for private enterprises and industry (Cantwell, 1995; Dalton & Serapio, 1999; Narula & Zanfei, 2003). However, the internationalization of R&D has recently begun receiving attention as a policy phenomenon as well (Schuch et al., 2012). International cooperation in R&D has been proposed to stem from an expansion in academic branches and experts, greater complication in subject matter, and the rising quality of mandatory research equipment and related expenses (Abramo et al., 2009; Katz & Martin, 1997). Another study examined factors that affect a given country's policies and strategies to facilitate international S&T cooperation: existing global issues, national S&T innovation capacity, foreign diplomatic environment, global research competence, national competitiveness, and scarcity of national natural resources (Boekholt et al., 2009). The general construction of international networks for collaboration in S&T has been referred to as open innovation, open R&D, or R&D global networking (Gassmann et al., 2010). With growing awareness of the importance of R&D collaboration, international joint research has increased, with improvements in project operation, progress management, and outcome analysis (Olk et al., 1998).

The classification of activities qualifying as international joint research varies between studies. Archibugi and Michie (1995) apply the term global technological collaboration for R&D

partnerships between governments and firms from different countries, and Wagner and Edelmann (2002) describe cooperation networks, which are characterized by inter-company IT support and knowledge exchange. In this paper, I use international research cooperation, international S&T cooperation, or international S&T joint research to refer to activities such as collaborative research and researcher exchange that have been initiated by an international agreement.

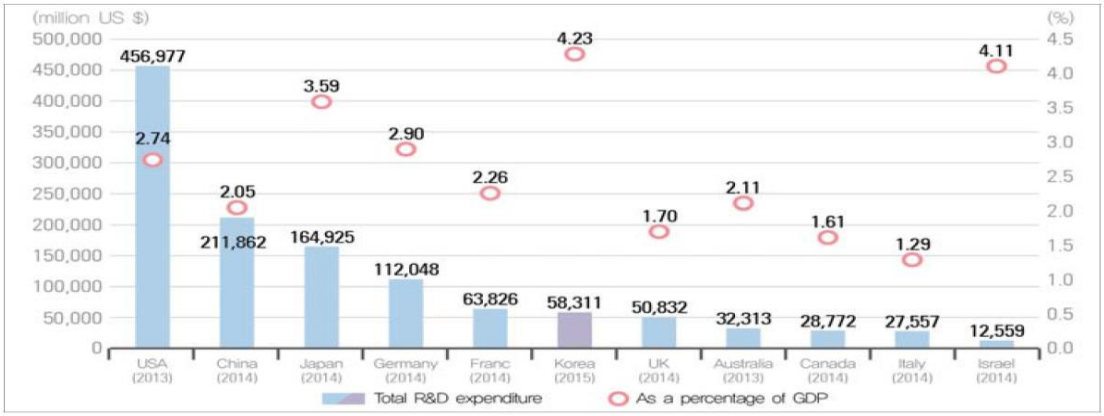
China's development has prompted a flurry of studies on the nation's R&D internationalization. Zhenzhong Ma et al. (2009) evaluate China's technological capacity and frequency of international research cooperation using data on joint patent applications between China and other OECD countries submitted to the USPTO. Chia-Wen Hsu (2015) uses the intensity and diversity of national high-tech ventures as measures of innovation outcomes and R&D internationalization. In comparison, similar research on South Korean R&D internationalization is sparse. In one study, Mariko Sakakibara et al. (2002) compare cooperation policies in South Korea and Japan in terms of government-sponsored R&D consortia, and highlight the fact that Korea is protectionist in its industrial policies, which strongly prioritize the success of chaebols over potential gains from open innovation.

The next section will use existing literature and data on government-initiated international joint R&D research in Korea and China to analyze the extent of international S&T cooperation in each country.

3 Current State of International R&D Cooperation

As countries increasingly learn to benefit from externally-sourced S&T knowledge, investment in cooperative R&D has seen a general upward trend. OECD statistics show that Korea ranked sixth worldwide in R&D expenditure, with a total of 58,311 million USD in 2015 and an R&D investment-to-GDP ratio of 4.23%—the highest in the world. On the other hand, China invested 211,862 million USD to R&D, ranking second in the world with its R&D investment-to-GDP ratio of 2.05% (OECD, 2016).

Figure 1: R&D expenditure as a percentage of GDP

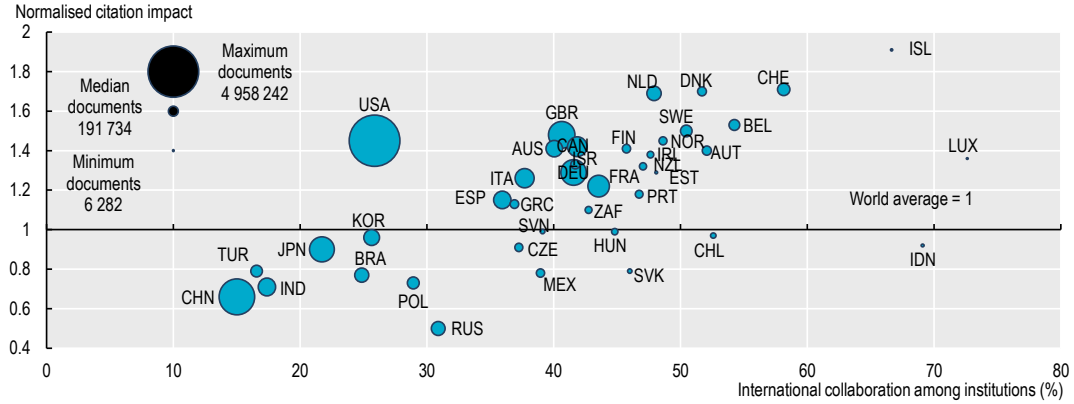


Source: OECD, Main Science and Technology Indicators 2016-1, 2016

Between 2003-2012, Korea's citation impact factor was close to the OECD average, while the nation scored poorly on the international collaboration scale—below average at 26%. While China

enjoys a higher absolute number of academic articles, it performs poorly on both the international collaboration scale and impact factor.

Figure 2: The citation impact factor and the extent of international collaboration



Source: OECD, Science, Technology and Industry Scoreboard, 2015

Differences also emerge in the national affiliations of authors and inventors in cooperative projects. Those from Japan, Korea, the US, and other developed countries participate in lower levels of co-authorship than those from China. In Israel, Belgium, and Switzerland, more than 25% of total scientific publications and patents list co-authors or co-inventors, and this number reaches 10% to 15% in Nordic countries. 25% of Korea's scientific papers and patents are cooperative, with a proportion below 20% in China. Both countries remain below the OECD average in this measure.

Figure 3: Co-authorship and co-invention as a percentage of scientific publications and IP5 patent families, 2003-12

Source: OECD, Science, Technology and Industry Scoreboard, 2015

4 Analysis of Government R&D Joint Project in Korea and China

1) South Korea

In South Korea, policies have been implemented to steadily push the reinforcement of S&T diplomacy and cooperative research in target sectors. S&T cooperation has expanded in sectors such as space science, aeronautics, marine science, pathology, climate change, renewable energy, medicine and other strategic fields as well as areas requiring global coordination. Korea has also constructed an international network for R&D coordination through initiatives to attract foreign talent.

Within the sphere of all national R&D projects, the share of international R&D research is relatively low, at 1.3% compared to other countries such as the US (24.6%), Germany (8.4%), and China (7.0%). More than 50% of such activity in the world occurs in these three countries.

Table 1: International R&D and international cooperation agreements signed by the Korean government

	2012	2013	2014	2015
Total number of international research cooperation projects	868	536	232	602
International research cooperation project share of total projects	1.7%	1.2%	0.5%	1.3%
Number of cases of international research cooperation	868	700	495	705

Source: KISTEP National R&D Program Survey Report, 2016

By category, the 294 cases of international research cooperation agreements account for the greater part of total international R&D, at 59.4%, followed by the 153 cases of information exchange accounting for 29.6% and 67 cases of foreign researcher invitation at 13.9%.

Table 2: Participants of international cooperation research agreements with Korea (2015)

	USA	Japan	China	Germany	France	England	Canada
Attraction of foreign researchers	22	4	5	4	1	7	4
Deployment of labor overseas	1	-	-	-	-	1	-
Information exchange	1	7	11	9	2	3	2
Technology research	1	-	-	-	-	-	-
International agreements	55	16	18	40	45	16	8
Commissioned research	104	6	15	-	2	11	5
Cumulative total	244	33	49	59	50	38	19
	34.6	4.7	7.0	8.4	7.1	5.4	2.7

Source: KISTEP National R&D Program Survey Report, 2016

International cooperation and commissioned research projects occupy 54.2% of the Ministry of Science, ICT, and Future Planning (MSIP), and 23% of the Ministry of Trade, Industry and Energy (MOTIE). Of these, the most influential projects foster relationship-building through cooperative foundational research with foreign researchers including Nobel prize winners, culminating in the construction of the Global Research Lab (GRL) that promotes the reinforcement of global cooperation networks.

Every year, the Global Research Lab provides financial support to approximately 50 projects, allocating budgets of up to 447,000 USD per laboratory. Similar support agencies aim to expand collaboration with globally leading scholars to improve South Korea's global research network, and may grant up to 89,000 USD for science and engineering projects, and 72,000 USD to humanities and social sciences projects. Initiatives to attract foreign talent may receive up to 536,000 USD over a 6-year period.

The Institute Pasteur Korea (IPK) was built as the result of one cooperative project with the intention of combining the fruitfulness of the Institute Pasteur in France with South Korea's strong research capacity. A collaboration with the Max Planck Gesellschaft (MPG) research center in Germany also led to joint studies of polysubstance matter currently in progress in Korea. In addition, the government set up strategic positions in Central and South America, China, Southeast Asia, and the Indo-China Peninsula to secure resources in the biodiversity sector.

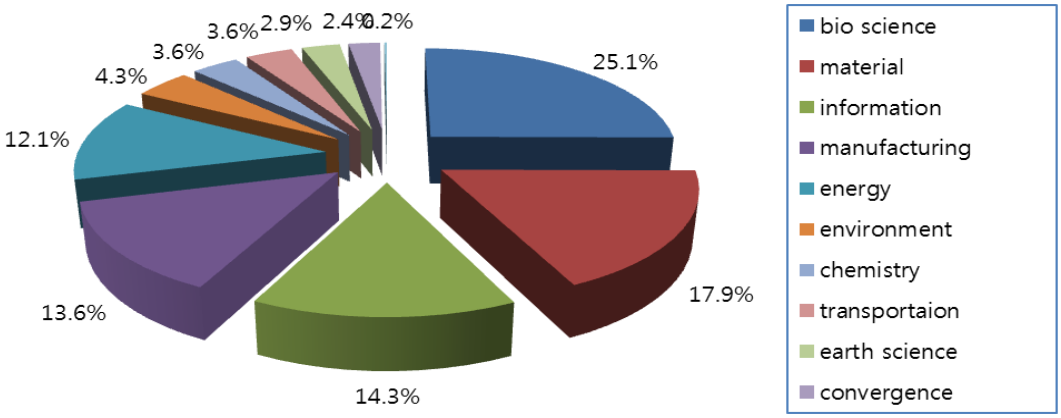
This year, the Ministry of Trade, Industry and Energy (MOTIE) actively developed global technology cooperation plan for the Fourth Industrial Revolution. Both governments signed an agreement on cooperative high-tech manufacturing and promised joint support in the fields of virtual reality and advanced new materials. As part of its plans to diversity and expand digital content exports, the MSIP is seeking connections with agencies in France and China to access new overseas markets.

2) China

In its 13th 5-Year Plan, China outlined its newest S&T innovation and globalization strategy. The Plan placed emphasis on actively building global innovation networks and open collaboration systems. In addition, China plans to actively participate in global innovation governance, and improve processes for transferring innovation resources to raise the national level of S&T innovation. China's International Cooperation and Exchange Projects are part of an initiative to facilitate international or governmental S&T innovation exchange, as well as a platform that enhances national innovation capabilities by employing resources from the international level. This program focuses on boosting international S&T joint projects under the following categories: (1) projects sanctioned under intergovernmental agreements; (2) activities related to economic and societal sustainable development or national security; (3) projects combining enterprise and labor through cooperative R&D with leading research agencies, universities, and corporations.

International S&T joint projects in 2015 numbered 414. By sector, 25% of these were in bio science, 17.9% in material, 14.3% in information, 13.6% in manufacturing, and 12.1% in energy.

Figure 4: International joint projects by industry (2015)



Source: Ministry of Science and Technology, International S&T Cooperation Program Annual Report 2015

The percentage of international joint projects by sector shows the share from business enterprise is much higher than projects conducted by universities and research institutes. When viewed by type of R&D, applied research occupies the highest proportion.

Figure 5: International joint projects by sector

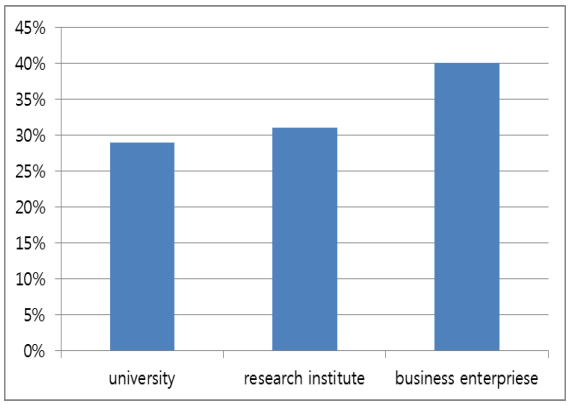
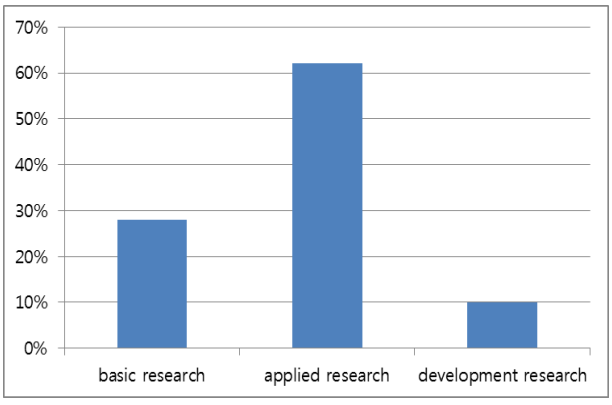


Figure 6: International joint projects by R&D type



Source: Ministry of Science and Technology, International S&T Cooperation Program Annual Report 2015

Sorted by category, 294 projects mandated by international agreements accounted for 56.9% of the total, 153 projects in information exchange for 29.6%, and 67 projects for the attraction of foreign researchers for 13.9%.

China's partner countries from highest to lowest frequency in collaboration are Russia, the US, Germany, Israel, England, the Netherlands, Canada, and Japan. Joint work with developing countries accounted for 3.6% of all collaborative research activity.

Table 3: International joint projects by partnering country

	Project expenses	Total expenses	Number of projects	Priority
Russia	3.59	11.46	84	27
US	2.19	6.32	77	24
Germany	0.69	3.36	26	8.2
Israel	0.36	2.25	26	8.2
England	0.63	1.78	23	7.3
Netherlands	0.98	2.91	20	6.4
Canada	0.38	0.94	16	5.0
Japan	0.38	1.03	16	5.0
South Korea	0.24	0.82	15	4.8
Italy	0.35	1.35	12	3.8

Source: MOST, International S&T Cooperation Program Annual Report 2015

China has been focusing on “One Belt One Road” Strategy to support companies that develop international markets and potentially improve their international market share. With neighboring countries, it aims to boost S&T labor exchange, establishment of joint laboratories, cooperative S&T development, and technology transfer. A strategic push of large-scale joint research in basic science and energy with developed nations such as the US and EU countries is also outlined. In addition, Germany and China agreed cooperation for fourth industrial revolution, with Germany proposing approximately 20 joint projects. China is also looking to bolster official development assistance via S&T joint activities. An S&T partnership plan with Central Africa will support sectors such as agriculture, disease prevention, and energy, while programs with Central Asia will conduct jointly established data sharing platforms and assisted research.

5 Korea-China S&T Joint Project Analysis

After the Korea-China S&T Cooperation Agreement was signed in 1992, a ministerial S&T joint committee and a vice minister-level joint committee began operation on a biannual basis. A Korea-China S&T cooperation center has been established in Beijing to act as a window for joint activity. 20 joint research projects annually facilitate delegate exchange, collaboration between emerging researchers, nuclear research, and a Korea-China S&T innovation forum.

For the 25th anniversary of this cooperation, experts working in related projects in each country were interviewed for their insight on Korea-China S&T joint research and to enhance the development of this partnership.

"The last 25 years of S&T cooperation shows that differences exist between demand from Korea and China. Korea is interested in China's basic technology, as well as its application of research infrastructure; China focuses more on Korea's industrialization technology. With the rapid rise of Chinese development, China's technological capabilities now approach or surpass those of Korea, leading to intense competition and a situation in which it is becoming increasingly difficult to realize practical cooperation."

On a similar vein, according to expert commentary at the recent conference in Korea, It is difficult to reconcile more and more between Korea's component enterprises and China's assembly enterprises.

Even though countries like the US and Germany are leading in the AI and Smart technology sectors, Korea and China, after the Fourth Industrial Revolution, lack investment and data for priority industries, and seem to be lagging behind due to inadequate labor mobility, technological advancement, quality of education, and other factors. Without a sound partnership, it will not be easy to close this gap. There have been many instances in the past where Korea invested in Chinese ventures, but recent Chinese ventures entering Korea are not seeing effective coordination.

6 Conclusion

This paper has considered international R&D cooperation in South Korea and China in terms of government policies, industry and sector categories, partnering countries, and priorities for the future.

Korea and China must now navigate a changing paradigm of cooperation. As shown when examining international cooperation patterns, Korea has pursued joint projects mainly with the US, while China partners the US, Russia, and Germany. Korea still maintains relatively small-scale involvement in international joint research, mostly supporting projects bound by intergovernmental agreements. Its national policies are designed to boost international technological cooperation and, in turn, promote open innovation, especially in the fields of climate change, renewable energy, pollution, and global problem solving. China, on the other hand, focuses on projects in which it can strategically advance large-scale joint research in basic science and energy while networking with the US, EU and other developed regions.

Thus, Korea and China both prioritize international cooperation. However, research on international cooperation in each country is lacking, and OECD statistics show that they perform poorly in patent co-invention and research co-authorship. In addition, poor trust amongst businesses from each country and significant uncertainties prevent active collaboration between them. To remedy this, each government and relevant institutions must build an effective platform through which ventures can share information and form strong partnerships. Though China and South Korea come from different political backgrounds, continuous effort is required to seek a strategic path to fruitful cooperation.

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