

International R&D linkages of universities and PRIs

International R&D linkages can enhance knowledge development and the diffusion of new technologies and address, more efficiently, global challenges. Numerous aspects of countries' economies, geography, labour force, law and mode of innovation and science can facilitate or hinder the development of the R&D base and international research linkages. Data show that there is a positive correlation across countries between the indicators for international scientific collaboration and patent applications. Smaller countries tend to have higher rates of international collaboration, which may be partly driven by the need to overcome limited opportunities to collaborate domestically and, in some cases, by proximity to external centres of knowledge. International R&D linkages are also affected by IPR regimes and mobility of scientists and engineering. OECD countries are increasingly promoting policies to strengthen international R&D linkages in order to facilitate the technological activities of firms and their co-operation with universities and PRIs in foreign countries. With globalisation, countries are increasingly trying to attract foreign R&D, with the aim that these activities will create spillovers into national companies.

What are international R&D linkages?

International R&D linkages refer to different ways of international collaboration in scientific and technological research. International R&D linkages can take different formats, including: international co-invention and co-authorship, licensing, mobility of researchers and engineers, dissemination of research results through international conferences and journals, open access to research data and networks, joint research project calls and funds, institutes and facilities, and foreign direct investment (FDI) (OECD, 2013; Archibugi and Iammarino, 2002; Narula and Hagedoorn, 1999). These linkages allow universities, PRIs and companies to tap into global pools of knowledge, to have access to major research facilities and human resources, to share costs, to obtain more rapid results, and to manage the large-scale efforts needed to effectively address challenges of a regional or global nature (OECD, 2012). Greater access to knowledge fosters a wider scope of scientific and industrial investigation and discovery. The development of R&D linkages involving universities, PRIs and companies across countries can be facilitated by institutional relationships, such as formal work agreements and co-operation activities.

What impacts can international R&D linkages have?

International R&D linkages can be important in the development of national innovation systems and in addressing global challenges. They can enhance the R&D base of companies, universities and PRIs. They can also have important effects on the diffusion of knowledge, on the development of research, on the creation of new projects and on the spread of knowledge.

Potential benefits of international R&D linkages

- **Promoting economic development:** the development of international R&D activities can have significant positive multiplier effects on the economy.
- **Addressing global challenges:** addressing international STI resources to address global and exchange of scientific data across borders.
- **Reducing the costs of research, development and innovation activities:** through co-ordinating international exchange of scientific and technical information.
- **Enhancing technological spillovers and knowledge diffusion:** technology and knowledge spillovers can be enhanced through the discussion of various ideas and approaches.
- **Increasing the bidding and winning in international calls for research funding:** the availability of research funding can be increased by the development of international R&D linkages, thus attracting more companies, academics and PRIs from across national borders.

- Enhancing opportunities for co-publication and co-patenting: creating new knowledge and developing relationships between international researchers, engineers, scientists, etc.

Incentives to developing international R&D linkages

- Accessing opportunities: international research, factor-driven collaboration with practitioners, foreign direct investment, human resource and technology capabilities, and with startups, scientists, engineers and researchers.
- Developing the environment and the relevance of national research for international research and fostering research and innovation: exchange of knowledge and integrating national research into global knowledge production networks (OECD, 2013).
- Promotion of open science and open innovation models: increased R&D collaboration and cross-institutional collaborations. Open innovation models, the linking of companies' internal innovation units and processes with external actors, including research units.
- Geographical and like cultural proximity: geographical proximity, and good transport linkages between countries can also have a positive impact.

Barriers to international R&D linkages

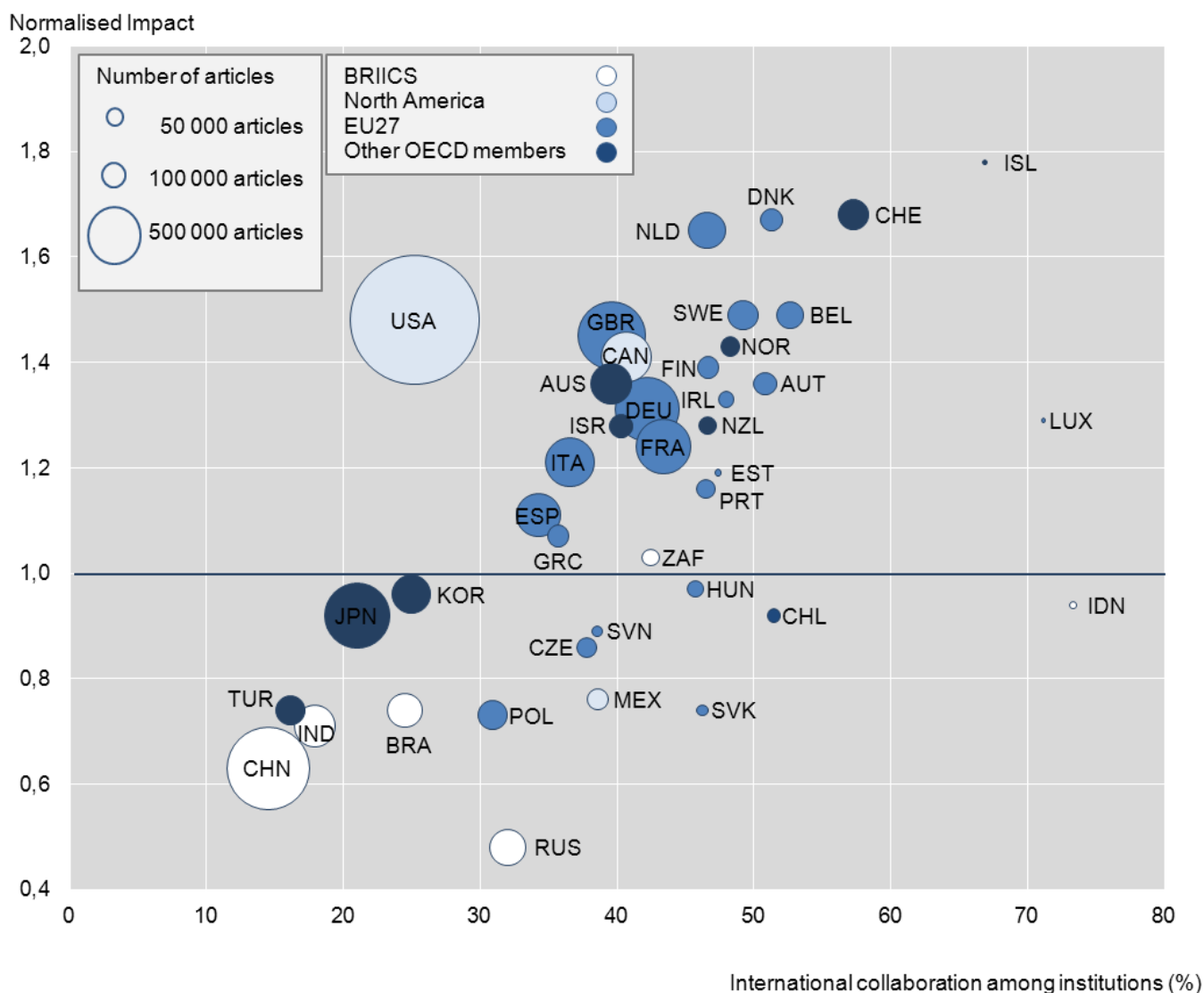
- Limited skills base: countries with a low level of skills, particularly in science, technology, engineering and mathematics (STEM), are likely to receive less offers of international collaboration and inflows of foreign direct investment (FDI).
- Unfriendly intellectual property regimes: an IPR regime conducive to international scientific and research collaboration provides a further channel of promoting international R&D linkages.
- Limited presence of multinational companies: multinational companies are likely to engage in research programmes with universities and PRIs. Multinational corporations often have R&D units and their production systems in several countries, resulting in co-inventions and co-discoveries (OECD, 2011). Likewise, the capacity of companies, institutions and countries to engage and up-scale innovation activities will also determine the level of R&D collaboration, co-patenting and co-publication.
- Low levels of international mobility of scientists and researchers: researcher mobility is considered key for the production and diffusion of knowledge and innovation, and for establishing international R&D linkages.
- Brain drain: national or regional authorities will want to receive the appropriate compensation or reward for investing in education and innovation, and could fear that international R&D collaboration will lead to "brain drain".
- Excessive regulations on technology sharing or selling to foreign companies and institutions: regulations on public research agencies and export policies on technology can limit the potential for innovation and research symbiosis.

What is the evidence on international R&D linkages and their contributions?

Evidence shows the increasing importance of international R&D linkages to the development of research systems, national economics and innovative companies. Figure 1 demonstrates how international collaboration in research is intensifying and how new players are emerging in the research landscape. The scientific knowledge production data shows a work trend of moving from individuals to groups, from single to multiple research-performing organisations and from a national

Figure 2 shows differences across countries that suggest a positive relationship between measures of research openness and scientific impact, the latter proxied by the average normalised citation index.

Figure 2. The impact of scientific production and the extent of international scientific collaboration, 2003-09



Source: OECD and SCImago Research Group (CSIC) (forthcoming), Report on Scientific Production, based on Scopus Custom Data, Elsevier, June 2011.

Figure 2 reflects how international co-authorship is more widespread for scientific publications than for patented inventions in almost every country. There is a positive correlation between the indicators for international scientific collaboration and patent applications across countries. Smaller countries tend to have higher rates of international collaboration. This might be driven by proximity to external centres of knowledge and the need to overcome limited opportunities to collaborate domestically (OECD, 2011).

In an OECD survey of PRIs, the share of funding from abroad had increased for more than half of responding institutes (OECD, 2010). Interestingly, the institutes with the highest level of foreign income were those that had research with a global dimension, such as relating to health or energy (OECD, 2011).

Figure 1. International co-invention, number of PCT patent applications

What other topics are connected with international R&D linkages?

International R&D linkages are closely related to:

- Mobility of scientists and engineers: mobility across companies, industries and academia can stimulate knowledge transfer, application of knowledge to new problems, and lead to the adoption of best practices, greater openness, creativity and innovation.
- R&D collaboration between firms and public sector research: universities and PRIs may provide access to firms to develop R&D infrastructures needed for the design and testing of innovation products and processes. Firms may not only use these infrastructures to solve their problems but also have an opportunity to learn from scientists and engineers sharing these facilities with their employees. R&D co-operation among firms can also achieve economies of scale and scope, and lower their transaction costs. Small and medium-sized enterprises (SMEs) should be a special focus, as they lack the financial, human and other resources needed to establish R&D linkages.
- IPR regimes: proper legal and regulatory frameworks providing guidance to universities, PRIs and companies on how benefits and/or ownership should be shared in the course of the research work could encourage research collaboration between universities and PRIs across countries.
- Open Science: ICT-based research platforms can serve as a “meeting point” for minds to interact, exchange and produce new knowledge, leading to new research questions and discoveries. These online platforms can have a multiplier effect on people-based knowledge exchange by increasing international R&D linkages, in terms of the participants and the flow of ideas and knowledge that is exchanged.

What policies can influence international R&D linkages?

Governments can further strengthen international R&D links. Policy initiatives, such as international partnerships, and the development of funding streams and collaboration arrangements among researchers, industries and other stakeholders, have been introduced in various countries to improve the speed with which advanced knowledge is generated and applied. Other key policies actions include assessment of the country’s comparative advantage in research and innovation activities, international collaboration mechanisms, programmes, work culture, and technological complementarity with international research networks. To this end, a range of programmes and strategies are set out in Table 1.

Table 1. Recent policy developments to promote international R&D Linkages

Policy instrument	Objective of the policy	Rationale	Mechanism
Governance models for international co-operation in STI	Increasing international co-operation in STI to address global	Institutional failure	Regulatory

	challenges.		
	Improving international interactions and matching between universities, PRIs and firms R&D activities.		
International co-operation strategies (e.g. Joint Programming Initiatives).	Co-ordinating and harmonising priorities and research agendas, technology transfer initiatives, and international exchange of Scientifics.	Coordination and systems failures	Regulatory
	Reducing costs and duplication of efforts.		
	Developing the absorptive capacity of national research systems and companies.		
	Combining the comparative strengths of different countries.		
	Sharing research infrastructures.		
Funding for participating in global R&D networks.	Supporting participation in international calls involving universities, academic and PRIs across national borders.	Institutional failure	Economic
	Detecting knowledge/capabilities/technologies located in other countries.		
IPR regimes	Developing IPR frameworks conducive to international scientific and research collaboration.	Framework or Institutional failures	Regulatory or information
	Providing guidance to universities, PRIs and companies on how benefits and/or ownership should be shared in the course of the research work.		
Setting global standards on emerging technologies.	Facilitating international R&D co-operation.	Framework failure	Regulatory

Promoting international research mobility (e.g. staff exchange, simplification of visa procedures).	Encouraging joint publications, collaborative centres and joint employment staff. Improving the absorptive capacity of researchers and the socio-economic stakeholders. Promoting multidisciplinary research from universities and PRIs.	Network failure	Regulatory or economic
Evaluation and monitoring of innovation systems and innovation strategies	Identifying the strengths and mechanisms to participate in global R&D network. Evaluating national presence in the world technological scene.	Institutional failure	Regulatory
Clusters policies	Supporting SMEs, which increasingly have to compete internationally. Strengthening networking activities (e.g. thematic networks, S&T parks, technology platforms).	Network failure	Regulatory

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