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COMMISSION STAFF WORKING DOCUMENT

Accompanying the document

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on

'Enhancing and Focusing EU International Cooperation in Research and Innovation: A Strategic Approach'

{COM(2012) 497 final}

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This document is a Staff Working Document of the European Commission intended for information. It does not represent or prejudge any official position of the Commission on this subject.

INTRODUCTION: AIM OF THE STAFF WORKING DOCUMENT

This Staff Working Document accompanies the Communication 'Enhancing and focusing EU international cooperation in research and innovation: a strategic approach'. It presents background information, facts and data to demonstrate how the global picture in research and innovation is changing and how Europe is positioned within the international context, underpinning the need for a more strategic approach to international cooperation in research and innovation in Europe. The second part takes stock of how international cooperation in research and innovation has been developed at Union level over recent years under the Seventh Framework Programme (FP7), through Science and Technology Agreements, and with the help of funding provided through the Union's external instruments. The third section provides an overview of international cooperation activities developed by the Member States, as part of their own policies and programmes and within the context of the Strategic Forum on International Science and Technology Cooperation (SFIC). This is followed by a description of international cooperation activities by third countries and an overview of relevant multilateral fora and international organisations. A concluding section describes the basic elements of an information gathering system to be developed to support the implementation of the strategic approach to international cooperation in research and innovation. The final section also provides an overview of indicators that can be used to monitor the implementation and impact of the strategy.

1. A CHANGING WORLD

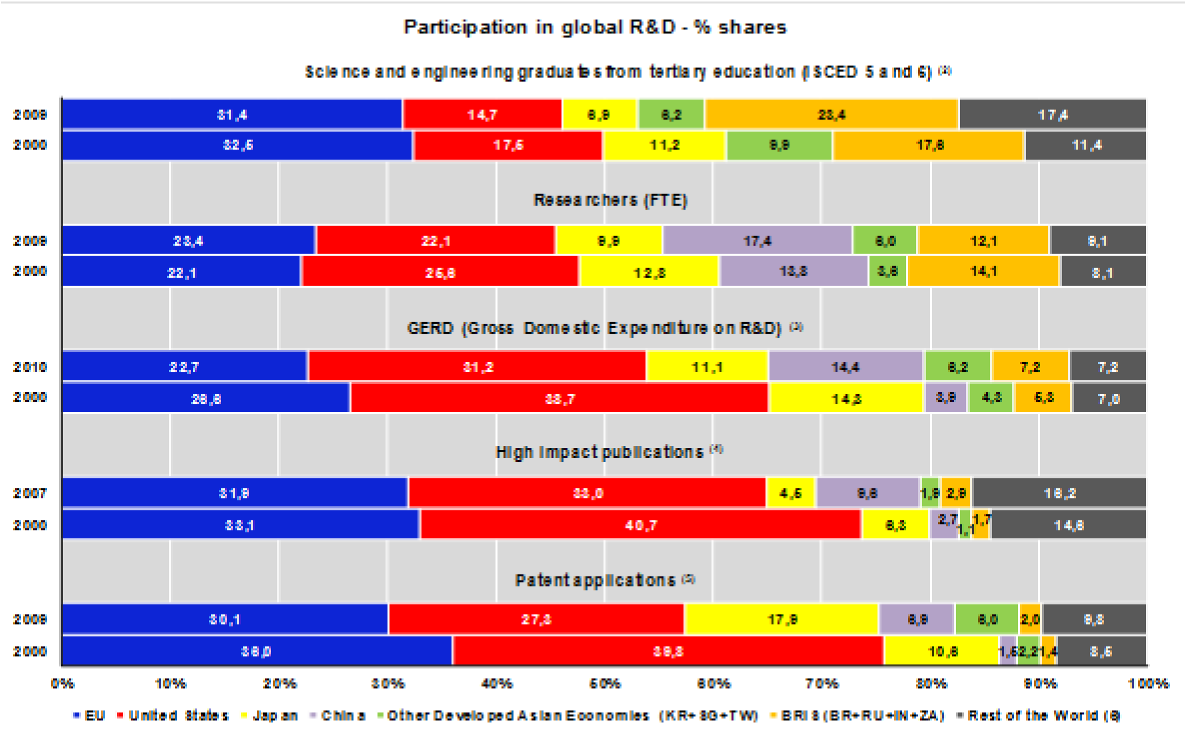
1.1 Evolution to a multi-polar world

The EU maintains its top position in science but is losing ground in technology development

The global picture in research and innovation is rapidly shifting. Emerging powers in science, technology and innovation, in particular the BRIC countries (Brazil, Russia, India, China), are challenging the USA, the Union and Japan. In this context, the Union's relative position on the global scene has remained remarkably stable over the last decade, except in R&D

expenditure and PCT patents[1], as illustrated in Figure 1. The evolution in the world share of PCT patent applications shares shows that both the Union and the USA are losing ground to the dynamic Asian economies. In general terms, the decline is more pronounced for the USA and Japan than for the Union.

Figure 1: World share of researchers, GERD, high-impact publications and patent applications, 2000 and latest year



Source: DG Research and Innovation
Data: Eurostat, OECD, UNESCO, Science Metrix / Scopus (Elsevier)
Notes: (1) Elements of estimation were involved in the compilation of the data.
(2) Tertiary graduates in science and engineering: (i) Data for China are not available; (ii) Other Developed Asian Economies does not include SG and TW; (iii) BRIS does not include India and South Africa.
(3) GERD: Shares were calculated from values in current PPS€.
(4) (i) Top 10% most most cited scientific publications - fractional counting method; (ii) Scientific publications 2007: citation window 2007-2009; (iii) Other Developed Asian Economies does not include SG and TW; (iv) BRIS does not include South Africa.
(5) Patent applications under the PCT (Patent Cooperation Treaty), at international phase, designating the EPO by country of residence of the inventor(s).
(6) The coverage of the Rest of the World is not uniform for all indicators.

Given the scale of the world's major research and innovation players, each Member State by itself lacks critical mass

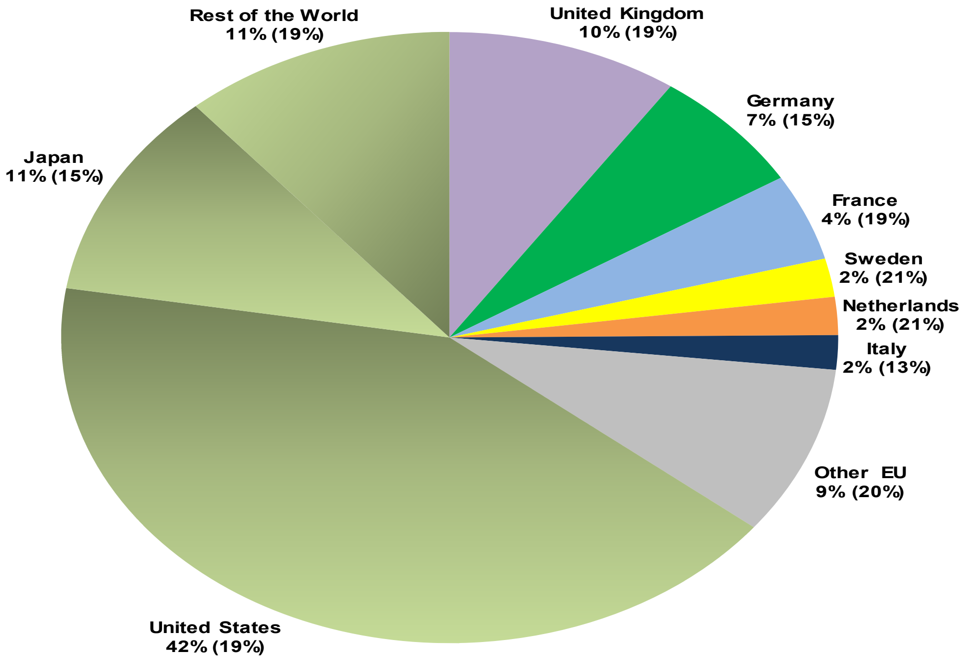
The multi-polar world of research and innovation has reinforced the scale effect, with each Member State becoming smaller in relative terms. Nevertheless, every Member State has increased its international cooperation with the emerging economies in absolute terms, as is illustrated in Figure 2 for cooperation with China.

The largest Member States account for only about 10% of China's international scientific cooperation, and most Member States account for less than 1% of Chinese international co-

[1] Patent Cooperation Treaty (PCT): provides for a unified procedure for seeking patent protection for an invention in each of a large number of countries, by filling a single PCT application. The granting of patents remains under the control of the national or regional patent offices.

publications. However, taken as a block, the Union represents over one third (36 %) of China's scientific cooperation with other world partners, making it China's second scientific partner after the USA (42 %).

Figure 2: Scientific co-publication partnerships between China and the world - % distribution, 2009 (in parenthesis average annual growth between 2000 and 2009)



Source: DG Research and Innovation
Data: Science Metrix / Scopus (Elsevier)

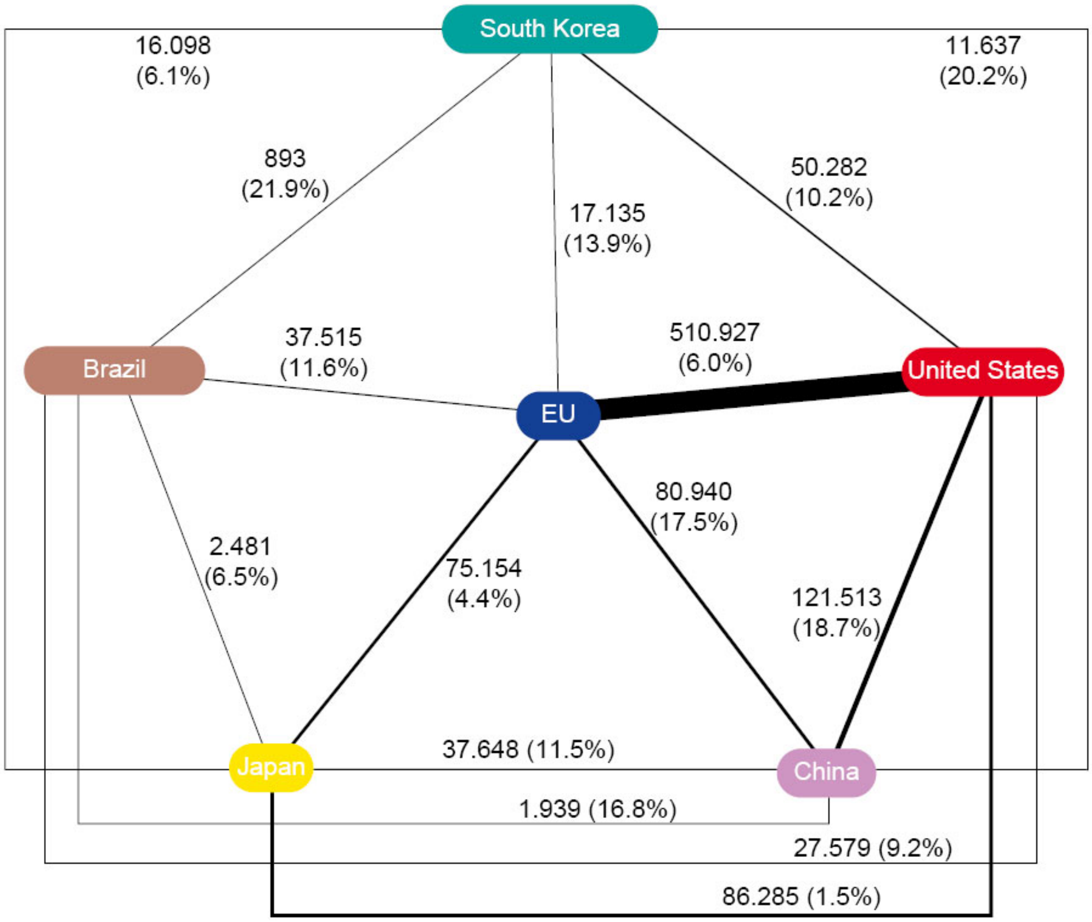
1.2. Internationalisation of the research and innovation system

Research and innovation are increasingly international endeavours, with scientists cooperating with peers from other countries. Looking at the Union's overall scientific production, almost one third (30 %) involves cooperation between researchers from different countries, a trend that has grown constantly (+8 %) over the last decade.

Scientific production is increasingly international. The USA has taken the lead in scientific cooperation with Asia.

It is relevant to monitor more closely the extent to which European researchers reach out to cooperate with colleagues from countries outside Europe, in particular with peers in the USA and in the rising Asian science and technology powers. Figure 3 provides an overview of scientific cooperation in the world. The figure shows that the major part of world scientific cooperation is still between the Union and the USA. However, the USA has developed greater scientific cooperation than the Union with all major research countries in Asia. The Union is slowly catching up in its scientific cooperation with Japan and South Korea, but continues to lose ground in its cooperation with China.

Figure 3: Scientific co-publications involving the Union, USA, Japan, South Korea, China and Brazil, 2000-2009



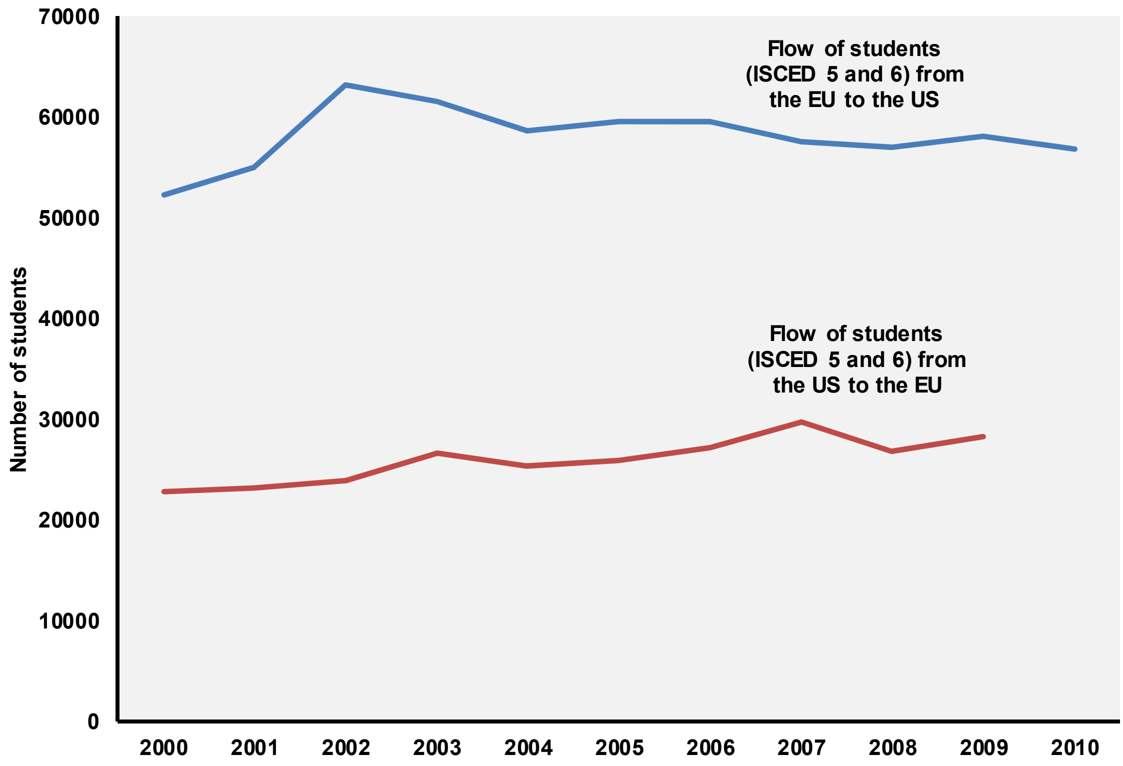
Source: DG Research and Innovation

Data: Science Metrix/ Scopus (Elsevier)

There are indications of a persistent brain drain from the Union to the USA

Scientific cooperation involves intensive mobility of research students and scientists. As a proxy for the mobility of researchers, Figure 4 illustrates the persistent flow of students and doctoral students from the Union to the USA. Over the last decade, the gap decreased slightly (it was widest in 2002) but remained significant in 2009-2010. In 2009, 58 000 students or early-stage researchers left the EU for graduate, master or doctoral studies in the USA, while only about half as many (28 200) left the USA to study or do research in the Union. The gap is largest for the Eastern European countries, but also for most of the Mediterranean countries. In contrast, the United Kingdom and Ireland have a positive balance for student or early-stage researchers. Half of US students and early-stage researchers, 14 300, went to UK universities, while 8 500 left the UK to study in the USA.

Figure 4: Mobility of students (ISCED 5 and 6) between the EU and the USA



Source: DG Research and Innovation
Data: UNESCO

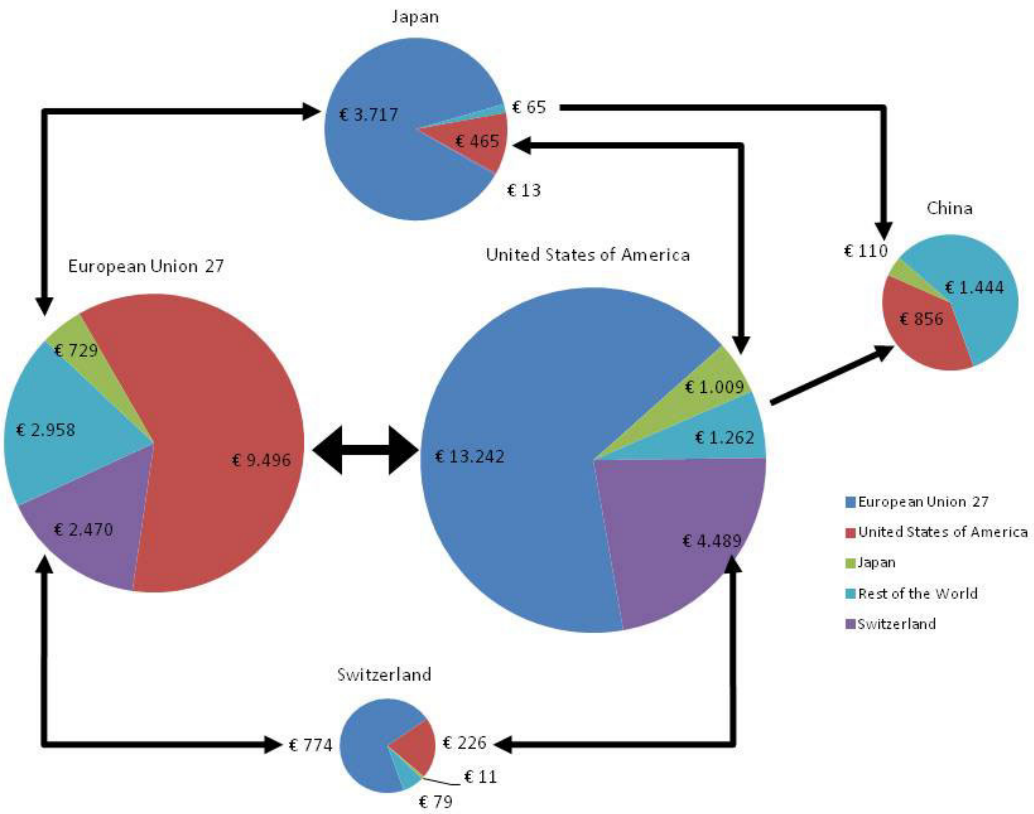
While the above data on students provides an indication, there are currently no solid data on flows of researchers between the EU and other world regions. However, surveys indicate that researcher mobility is still mainly between the EU and the USA, with larger flows of researchers from the EU to the USA than in the reverse direction. The main reasons cited by EU researchers for moving to the USA are job opportunities, educational opportunities and the existence of scientific or professional infrastructure.

Innovation is also becoming more international, within global value chains. The dominant investment flows in R&D are still between the USA and the Union.

Economic globalisation has also made innovation increasingly international. The internationalisation of the economy now covers the higher end of the value chain with increasing cross-border flows of business R&D. Globally, the internationalisation of business R&D is the result of relations between a small number of countries. Figure 5 illustrates these relationships for the manufacturing sectors of the Union, the USA, Japan, China and Switzerland. The size of the pie chart for each country indicates the total amount of R&D expenditure by foreign-owned firms in each country, while the pie slices represent the R&D expenditure of foreign-owned firms from a particular country.

As with scientific cooperation, the figure reveals the importance of the relationship between the USA and the Union. Taken together, R&D expenditure by US firms in the Union and by Union firms in the USA accounts for two-thirds of the R&D expenditure of foreign-owned firms in manufacturing world-wide[2]. The USA is also the largest investing country in the majority of the Member States. Union firms account for more than 65 % of the total manufacturing R&D expenditure of foreign-owned firms in the USA, or more than 90 % if other European countries not in the Union (mainly Switzerland and Norway) are included. However, the figure also shows a deficit in the EU's R&D investment flows to the USA. While Union firms invested EUR 13.2 billion in the USA, US firms invested only EUR 9.5 billion in the Union. This gap of almost 40 % is a sign of the higher attractiveness of the USA compared to the EU.

Figure 5: Overseas business R&D expenditure in manufacturing by the Union, the USA, Japan, China and Switzerland, 2007



Source: OECD, Eurostat, National statistical offices, DG RTD study calculations

Notes: 1) EU firms spent EUR 774 m on R&D in Switzerland in 2007; Swiss firms spent EUR 2 470 m on R&D in the EU-27 in 2007.

2) Swiss data also include the service sector; data for China are estimated based on national sources and US and Japanese outward data

2 The EU is considered as one entity, and intra-EU relationships (for example R&D by German firms in France) are not taken into account.

In recent years, China has emerged as a new location for R&D by foreign-owned firms. However, the Chinese data are incomplete and plagued by methodological issues, which render comparison with data from OECD countries difficult. The R&D expenditure of wholly foreign-owned companies in China is included in Figure 5, which is EUR 2.4 billion for the year 2007. No breakdown of this amount by different countries of origin is available.

The Union remains an attractive place to perform R&D but Asia is gaining ground

The evolution of these R&D investment flows from the perspective of the Union is of importance in assessing the attractiveness of the Union for research and innovation. Given that the main investment flows are still from the USA, Figure 6 shows the R&D expenditure of US firms abroad between 1994 and 2008. It includes the Union, Japan, other OECD countries (including Australia, Canada, Korea, Israel, Mexico or New Zealand), non-OECD Asia (including China, India, Taiwan, Singapore, or Malaysia), and the rest of the world (including Africa and South America).

The figure tells two different stories. In *relative terms*, the rise of Asian countries as R&D locations for US firms has led to a shift in the distribution of US overseas R&D expenditure. The share of the Union in US overseas R&D expenditure decreased from around 75 % in 1994 to around 60 % in 2008, with corresponding increases for Asian countries and non-European OECD member states. Much of the decrease in the Union share occurred during the 1990s; since the early 2000s, the EU share has remained remarkably stable at around 60 %

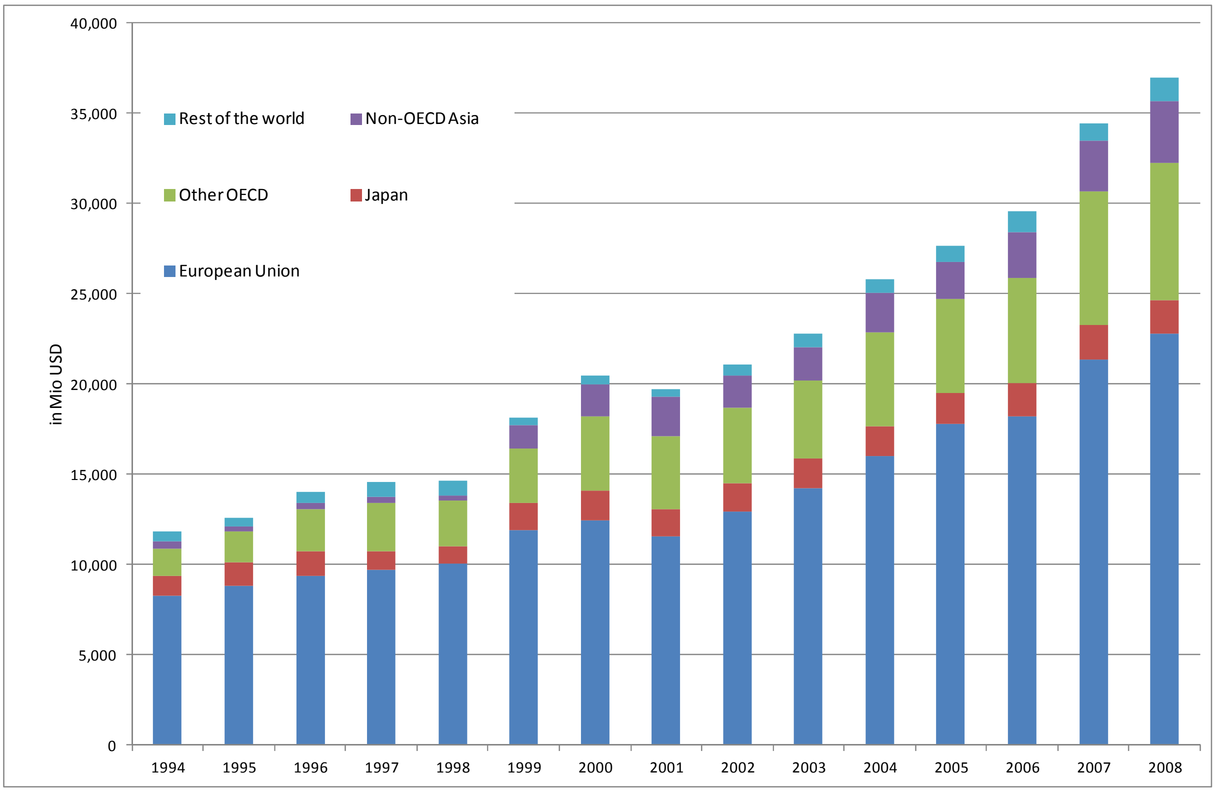
In *absolute terms*, however, R&D expenditure increased at each location, with overseas R&D expenditure by US firms in the Union more than doubling between 1994 and 2008. This does not indicate that US firms increased their R&D efforts in Asia at the expense of locations in the EU. The internationalisation of R&D is therefore not a zero-sum game. The Union remains an attractive R&D location for firms from outside the Union. Non- Union firms, in particular US firms, have continuously increased their R&D expenditure in the EU since the 1990s. Moreover, China and India are not only host countries for the R&D activities of foreign-owned firms: multinationals from India, China, Brazil or other emerging economies are just about to make their first steps into the Union as a location for their R&D activities. Some of these activities are not yet fully reflected in the currently available data.

1.3 The position of the Union in international research and innovation

The Union suffers from an innovation gap with the USA and Japan, but is slowly catching up

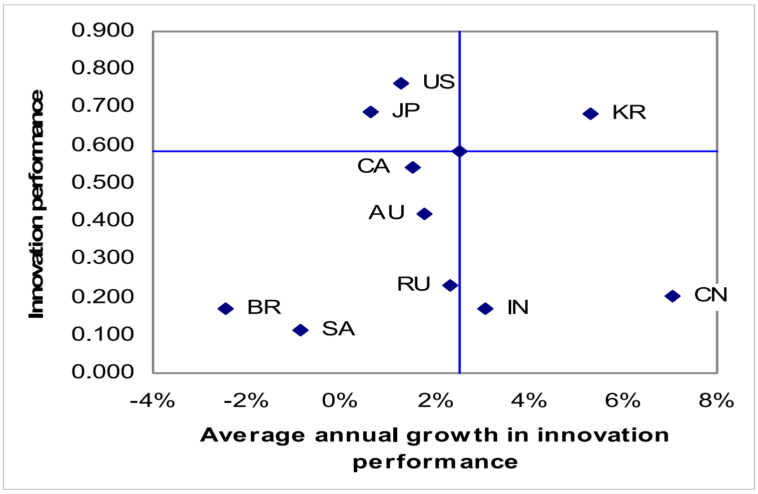
The innovation performance of most countries in the Union is progressing but not fast enough to close the persistent gap with the global innovation leaders, the USA, Japan and South Korea (Figure 7). The Union still maintains a clear lead over the emerging economies of China, Brazil, India, Russia, and South Africa. China is improving its innovation performance and is progressively catching up with the Union.

Figure 6: Overseas R&D expenditure of US firms, 1994-2008, USD m.



Source: OECD based on US outward data by the US Bureau of Economic Analysis, own calculations

Figure 7: Innovation performance and growth in innovation performance of the Union and its main competitors



World scientific specialisation and relative quality opens up international cooperation opportunities based on complementarities. The European countries are reference points in science for energy and the environment, while they are lagging behind the USA in scientific excellence in health, nanoscience, ICT and biotechnology.

The positional analysis graph, Figure 8, shows at a glance the performance of countries and regions across several indicators. The scientific performance of the Union (presented in the graph as ERA), China, Japan and the USA in the thematic priorities for the 2000–2009 period is illustrated based on their number of publications (i.e. the size of the bubble), their scientific specialisation score (horizontal axis) and their scientific impact (quality) score (vertical axis).

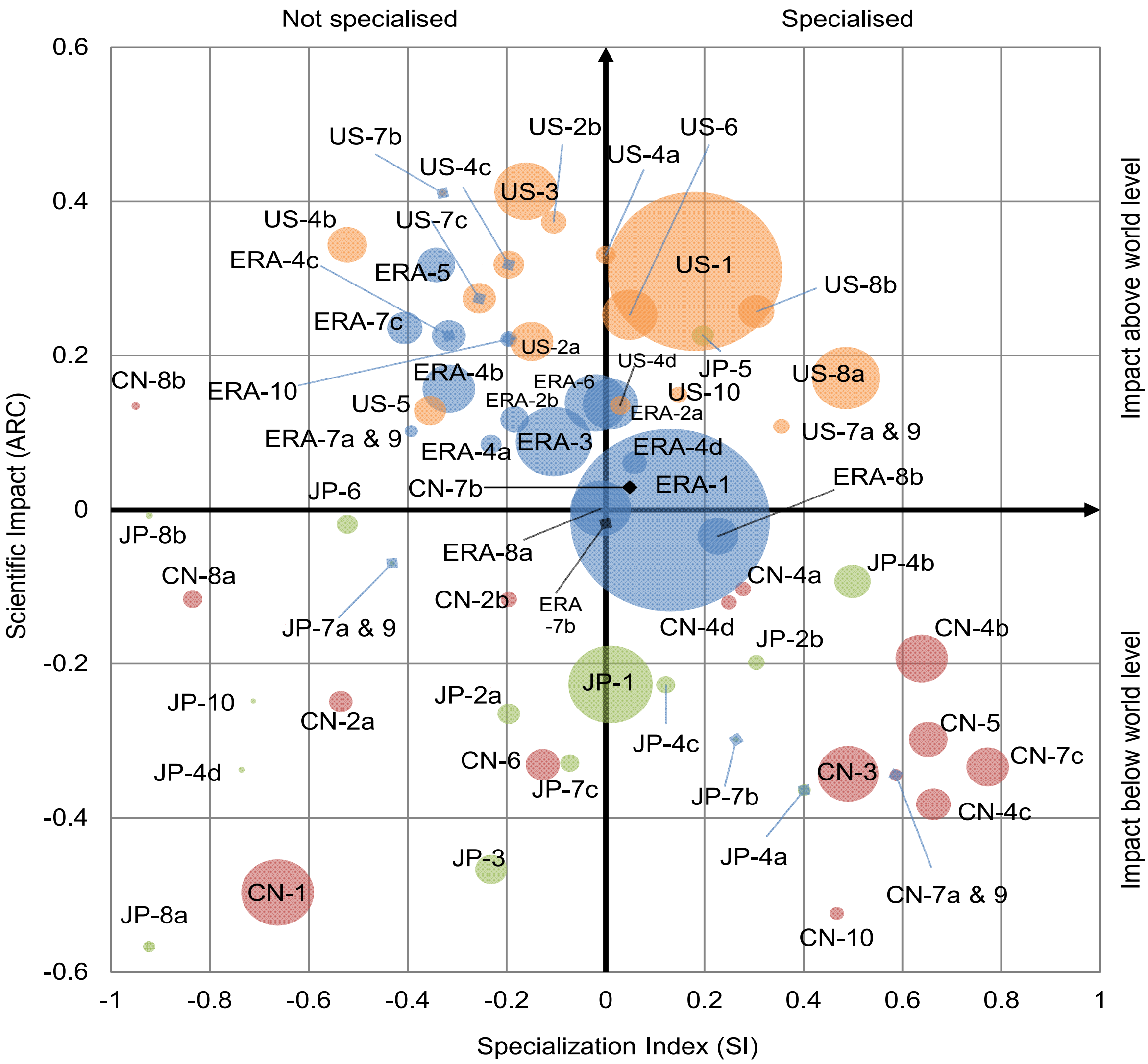
In most thematic priorities, the Union's position reflects its level of scientific impact at or above the world level, combined with a relatively low level of specialisation. In relative terms, the Union performs extensive research in all scientific fields and the only areas where it is more specialised than the world average is in the areas of health and humanities. The particular feature of the Union's scientific production is that it does not have the highest scientific impact (quality) in the few areas where it is specialised. The scientific performance of the Union in the FP7 thematic priorities rarely combines high scientific output, specialisation and impact. Only the USA achieves this for more than one priority.

Figure 8 shows that the Union does not have a particularly high impact in the fields of health and humanities, but has the highest level of impact in areas in which it does not specialise, such as energy, other transport technologies, new production technologies and security. Note that, in all FP7 thematic priorities, the Union's output (i.e. the total number of publications) exceeds or is close to that of the three countries to which it is compared.

The USA performs well in many fields, and achieves high levels of output, specialisation and scientific impact in health, environment, socio-economic sciences, and the humanities. It is also highly cited, albeit less specialised, in information and communications technology, biotechnology, new production technologies, materials (excluding nanotechnology), other transport technologies, and food, agriculture and fisheries. In contrast to the USA and the Union, China and Japan systematically have fewer citations in the FP7 priorities, although they are specialised in several areas. There is one exception: Japan performs strongly in energy research, combining a high level of specialisation with a high impact.

Health research (FP7 theme 1) constitutes the largest area of scientific production in all regions/countries considered. While the Union dominates in terms of gross output in this area, the USA shows a greater level of specialisation and scientific impact. Both Japan and China have a smaller output in health research than the Union and the USA, and are cited less frequently than the world average in this area.

Figure 8: Scientific strengths and weaknesses of the Union, 2000-2009



Legend: FP7 Thematic priorities			
1 = Health	4a = Nanosciences and Nanotechnologies	5 = Energy	7c = Other Transport Technologies
2a = Food, Agriculture and Fisheries	4b = Materials (excluding nanotech)	6 = Environment (with climate change)	8a = Socio-Economic Sciences
2b = Biotechnology	4c = New Production Technologies	7a & 9 = Aeronautics & Space	8b = Humanities
3 = Information and Communications Tech	4d = Construction and Construction Tech	7b = Automobiles	10 = Security

The technological specialisation of the world powers offers the Union clear opportunities for complementarities

The major technological areas in which Europe specialises and those where it is not specialised can be illustrated by the 'revealed technological advantage', which compares the relative importance of a given technological area in Europe's total patent production[3] to the relative importance of this technological area in all patent production worldwide[4]. Europe's major areas of technological strength are Food, Agriculture and Fisheries, Construction and Construction Technologies, Aeronautics, Automobiles, and Other Transport Technologies.

Asia's pattern of specialisation is, to some extent, complementary to that of Europe. The major areas of technological strength are Information and Communication Technologies together with Nanotechnologies, while no specialisation is found in technological areas such as Health, Food, Agriculture and Fisheries, Biotechnology, Construction and Construction Technologies, New Production Technologies, and Aeronautics and Space. The specialisation/non-specialisation pattern is much more pronounced in Asia than in Europe, which means that the level of concentration of patent production in Asia in its areas of technological strength is higher than in Europe (to the detriment of Asia's weaker areas).

In North America, we observe that Health, Biotechnology and Space are the major technological fields of specialisation. The fields of technological weakness in North America are Construction and Construction Technologies, Energy, Automobiles and Other Transport Technologies.

Table 1 below provides a summary view of the major fields of specialisation and non-specialisation for each geographical area, according to three different ways of classifying patents: by FP7 Thematic Priorities; IPC fields; and NACE sectors. The overall picture is relatively consistent across the three classifications. In particular, Europe looks strongly specialised in relatively traditional technological fields, related to transport and mechanical technologies, while at the same time major weaknesses are seen in fast-growing technologies associated with the ICT and nanotechnology areas. However in these areas there are sectors where European companies are well positioned[5] (e.g. telecommunications equipment and services, automotive electronics, semiconductor manufacturing equipment and medical equipment*)*.

[3] EU-27 and Associated Countries (i.e. countries associated with the research framework programmes).

[4] Based on patent applications to the European Patent Office (EPO), the US Patent and Trademark Office (USPTO), patent applications filed under the Patent Co-operation Treaty (PCT) that designate the EPO, as well as Triadic Patent Families..

[5] See http://spectrum.ieee.org/static/patentpower2010

Table 1 — Patterns of technological specialisation and non-specialisation by geographical area and type of classification, 2000-2010

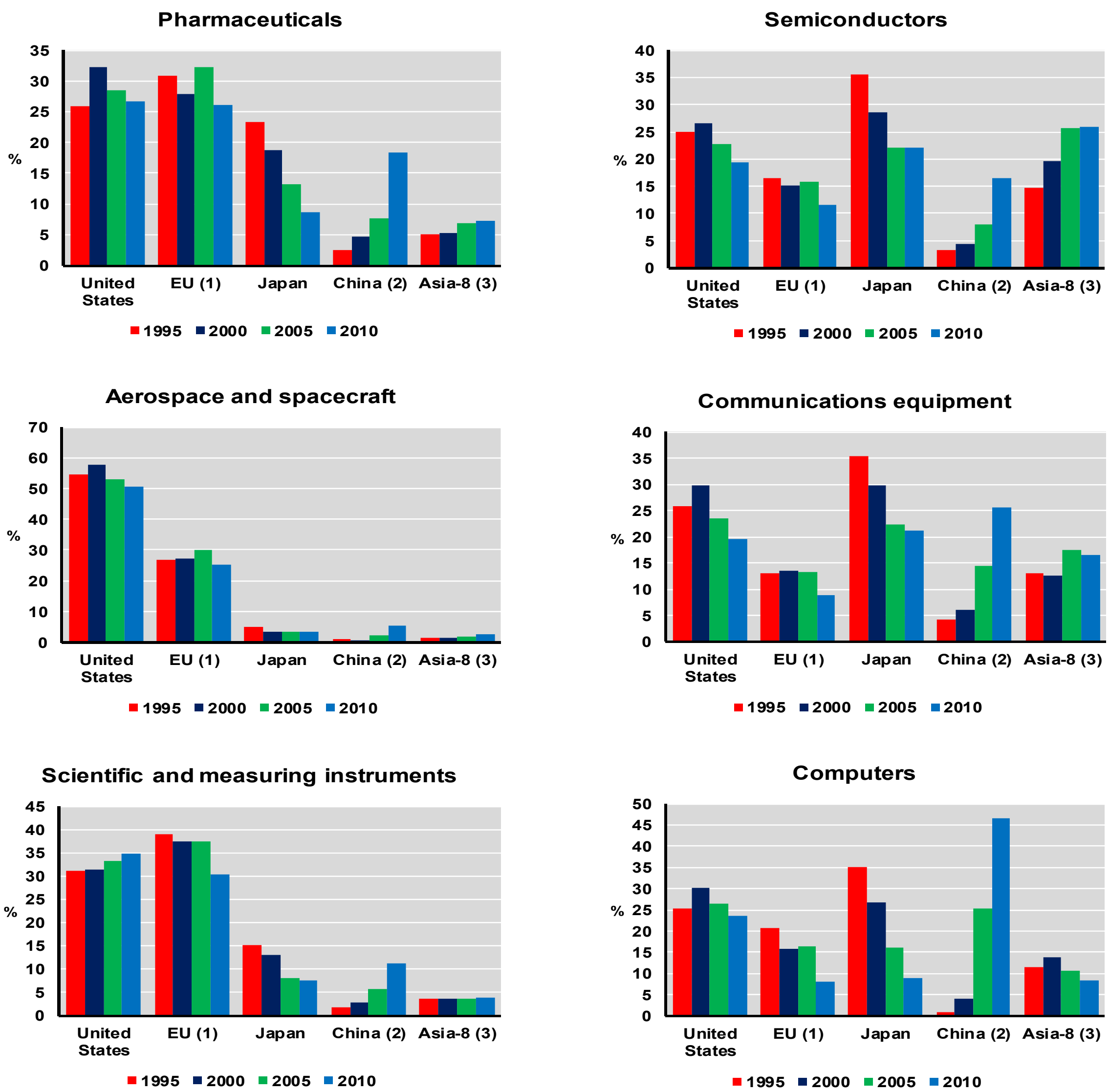
	Areas of	FP7 Thematic Priorities	IPC fields	NACE sectors
ERA	Strengths	Food, Agriculture and Fisheries Construction and Construction Technologies Aeronautics Automobiles Other transport technologies	Handling Machine tools Engines Thermal processes Other special machines Mechanical elements Transport	Food products and beverages Machine tools Plastic products Motor vehicles Aircraft and spacecraft
	Weaknesses	Information & Communications Technologies Nanosciences & Nanotechnologies	Audio-visual technology Telecommunications Computer technology IT methods for management Semiconductors	Office machinery and computers Electronic components Electricity distribution, control apparatus Services for computer and related activities
Asia	Strengths	Information & Communications Technologies Nanosciences & Nanotechnologies	Electrical machinery Audio-visual technology Telecommunications Basic communication processes Semiconductors Optics Textile machinery	Electronic components Electricity distribution, control apparatus Electrical motors, generators, transformers Office machinery and computers
	Weaknesses	Health Food, Agriculture and Fisheries Biotechnology Construction and Construction Technologies Aeronautics Space	Biotechnology Pharmaceuticals Furniture Civil engineering	Food products and beverages Pharmaceuticals Plastic products Medical and surgical equipment Aircraft and spacecraft
North America	Strengths	Health Biotechnology Space	Biotechnology Pharmaceuticals Computer technology IT methods for management Analysis of biological materials Medical technology	Services for computer Pharmaceuticals Medical equipment Reproduction of recorded
	Weaknesses	Construction and Construction Technologies Energy Automobiles Other Transport Technologies	Handling Machine tools Engines Textile and paper machines Thermal processes Mechanical elements Transport	Motor vehicles Electrical motors Machine tools Electroinic components.

Source: European Commission, 2012; SPRU

The Union's falling global share in high-tech industries calls for strategic cooperation

The internationalisation of innovation is linked to the broader globalisation of the economy, in particular the growth of high-tech industries outside the USA, the Union and Japan. The general trend over the last 10 years is a continuous fall in the global shares of the USA, the Union and Japan in these industries, due to the expansion of the other Asian countries, headed by China. This trend is particularly clear in pharmaceuticals and ICT-based manufacturing sectors, but also in scientific and measuring instruments. The aerospace sector is more stable, remaining dominated by the USA and, to a lesser extent, the Union. The Union's share of global value added fell most in the five years up to 2010. Considering the Union's relatively weaker scientific and, in particular, technological position in ICT, health and nanotechnologies, this is a worrying sign. Enhanced funding and strategic focus should go hand-in-hand with extended international cooperation in scientific and technological development.

Figure 9: Value Added for selected manufacturing industries – global shares (%)



Source: DG Research and Innovation
Data: NSF
Notes: (1) EU does not include Estonia, Cyprus, Latvia, Lithuania, Luxembourg, Malta and Slovenia.
(2) China includes Hong Kong.
(3) Asia-8 includes India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Chinese Taipei and Thailand.

2. INTERNATIONAL COOPERATION ACTIVITIES AT UNION LEVEL: TAKING STOCK

2.1 Stimulating the participation of third countries in FP7

The approach to international cooperation in FP7 is different from that used in earlier Framework Programmes. It aims to mainstream international cooperation across all parts of FP7, including the Euratom programme, through a dual approach of general opening and the development of targeted international cooperation actions.

The principle of general opening allows entities from all third countries to participate in FP7. However, not all such entities are automatically eligible for funding from the EU budget. Under FP7, automatic funding — other than to entities from Member States — is granted from the Union budget to entities from countries associated with the research framework programmes (Associated Countries) and the International Cooperation Partner Countries (ICPC). The list of ICPCs is adopted every year as part of the work programme. It contains those countries classified as lower income, lower-middle income and higher-middle income by the World Bank. Entities from other third countries are not automatically eligible for funding, but may receive it by way of exception provided it is essential for the project to be carried out successfully, as assessed when the proposal is evaluated, or when specified in an international agreement or the work programme.

This general opening is complemented, where appropriate, by targeted international cooperation actions where there is a mutual interest. This applies in particular to the themes of the Cooperation Specific Programme and parts of the Capacities Specific Programme. To this end, the following instruments have been used in FP7:

– Joint call: a single call launched, selected, evaluated and funded jointly in the Union and the third country in question.

– Coordinated call: a call launched and evaluated in parallel in the Union and the third country in question.

– Specific International Cooperation Actions (SICA): collaborative projects with compulsory participation of entities from the third countries or regions in question. In addition, some calls for Coordination and Support Actions have also made participation from third countries compulsory.

– Targeted opening: collaborative project or coordination and support action where the participation of entities from third countries or regions is evaluated positively.

– Networking (twinning) of entities participating in projects funded by the Union and third countries to promote the exchange of knowledge and scientists, mutual access to infrastructures or the preparation of further joint projects.

Across the entire FP7, some 680 targeted international cooperation actions (under the form of joint and coordinated calls, SICAs and topics for targeted opening or networking) have been included in the work programmes for 2007-2013, with the overwhelming majority (more than 90 %) coming under the Cooperation Specific Programme. The number of international cooperation actions included in the work programmes has been more or less stable throughout FP7, although there appears to have been a drop in the final years of implementation.

In terms of country groupings, the International Cooperation Partner Countries are the main group (of which the BRICS are a sub-group in FP7) along with the high-income countries, where the aim has been in particular to cooperate with the USA and Japan. In terms of themes, the Food, Agriculture and Fisheries Theme, the Biotechnologies Theme and the Environment Theme have the highest number of international cooperation topics in their work programmes, followed by the Health Theme, the ICT Theme, the Transport Theme and the Energy Theme.

The Marie Curie actions under the People Specific Programme have a substantial international dimension. They are designed to enable the best researchers from anywhere in the world to develop their careers in Europe, including through researcher exchanges with specific third countries. The global nature of many Marie Curie projects is shown by the fact that the host institutions coordinating Marie Curie projects are located in 80 different countries, of which half are third countries (i.e. neither Member States nor Associated Countries). In terms of mobilising the best talent from around the world, researchers of 130 different nationalities have so far received Marie Curie funding in FP7.

As a result of all these actions, about 21 % of the signed grant agreements under FP7 had at least one international partner as part of the consortium. Of those agreements:

– about 20 % included a partner from a high-income country or a partner from Eastern Europe and Central Asia;

– about 18 % included a partner from Africa or Asia;

– about 14 % included a partner from Latin America; and

– about 9 % included a partner from the Mediterranean region.

At regards countries, the top five participating third countries in FP7 are Russia, the USA, China, India and South Africa.

Some 2.3 % of the total FP7 budget is paid to international partners. Of this amount, about 26 % goes to African countries, about 17 % to the Eastern European and Central Asian countries, 16 % to Asian countries, about 13 % to both the high-income countries and the Latin American countries, and the remainder to countries from the Mediterranean region. As regards individual countries, the top five recipients of FP7 funding are Russia, the USA, India, South Africa and China.

2.2 FP7 Capacities Specific Programme

2.2.1 Dedicated international cooperation actions

The dedicated international cooperation actions under the FP7 Capacities Specific Programme support the international cooperation strategy of FP7 through carefully designed funding modalities aimed at promoting the participation of third-country participants in FP7 and programmes of the Member States, stimulating policy dialogue with third countries/regions, and launching studies on issues relevant to international cooperation:

– ***Supporting bi-regional policy dialogues:*** the INCO-Net scheme aims to strengthen and monitor progress in bi-regional cooperation between research and innovation actors. Target regions are ASEAN, the Caribbean, Central America, Central Asia and the Southern Caucasus, Eastern Europe and Central Asia, the Gulf, Latin America, the Mediterranean, the Pacific, sub-Saharan Africa and the Western Balkans.

– ***Supporting bilateral coordination activities:***

- BILAT: supporting networking between stakeholders in order to strengthen capacities in third countries, focusing on providing information on FP7 and identifying areas of mutual interest and benefit. Target countries are: Algeria, Argentina, Australia, Brazil, Canada, Chile, China, Egypt, India, Japan, Jordan, Korea, Mexico, Morocco, New Zealand, Russia, South Africa, Tunisia, Ukraine and the USA.

- ACCESS4EU: aiming to increase awareness among researchers in the Member States and Associated Countries of opportunities in programmes managed by third countries, identifying projects open to Union researchers and promoting their participation. This enhances reciprocity. Target countries are Australia, Brazil, Canada, China, India, Korea, Mexico, New Zealand, Russia, South Africa and the USA.

– ***Supporting coordination of the policies and activities of the Member States and the Associated Countries:***

- ERA-NET/ERA-NET+: aiming to step up cooperation and coordination of research and innovation programmes at national or regional level in the Member States or Associated Countries. The ultimate goal is the mutual opening-up, development and implementation of joint activities. Participating third countries and regions are: Africa, the Black Sea, India, Japan, Korea, Russia and South East Europe.

- ERA-WIDE: promoting closer cooperation with the European Neighbourhood Policy (ENP) countries and preparing for their possible association with the Framework Programme by reinforcing the cooperation capacities of research centres of the highest quality in these countries. Target countries are: Eastern Europe and the Southern Caucasus countries that are not yet associated to FP7, as well as most Mediterranean Partner Countries: Morocco, Algeria, Tunisia, Libya, Egypt, Jordan, the Occupied Palestinian Territory, Lebanon and Syria.

- INCO-LAB: aiming to increase cooperation with third countries by strengthening the catalytic role of joint research institutes, centres or laboratories funded by one or more Member States or Associated Countries and located in third countries. Target countries are: Brazil, China, India, Japan, Russia and the USA.

- INCO-HOUSE: supporting the opening of joint centres funded by one or more Member States and Associated Countries and located in third countries. The target country is India.

In addition, support has been provided to the network of National Contact Points for Activities of International Cooperation to stimulate transnational cooperation, and to the ERAWATCH project, which provides information on the research policies and programmes of the Member States, Associated Countries and third countries to support evidence-based policy making.

The table below provides an overview of the number of projects supported and their associated budgets.

INCO Projects Type	Number of projects	Total cost (EUR)	Total EU contribution (EUR)
ACCESS	11	6 712 146	5 309 112
BILAT	20	14 224 861	9 872 969
ERA-NET	7	20 179 830	14 898 658
ERAWATCH	1	310 652	299 997
ERA-WIDE	46	26 316 868	22 517 626
INCO-LAB	7	14 439 929	11 984 943
INCO-NET	11	34 945 877	29 988 074
NCP INCONTACT	2	2 817 378	2 369 822
Total	**105**	**119 947 541**	**97 241 201**

A mid-term review of the international cooperation activities under the FP7 Capacities Programme and a series of workshops resulted in the following key findings:

– ***Impact:***

- FP7 INCO-NET generates visible impacts, in terms of the development of international networks, increased bi-regional cooperation, knowledge of and participation in FP7-funded projects, visibility, contributions to bi-regional policy dialogues, effectiveness of National Contact Points, and research staff mobility.

- The BILAT, ACCESS4EU and ERAWIDE projects are highly welcomed by both European and third-country partners. Knowledge acquired through ACCESS4EU projects, for example, can make bilateral cooperation more effective.

- There are positive outcomes from the ERA-NET and ERA-NET Plus projects, leading to joint calls with third countries. However, their scale has remained rather limited. It is too early to draw conclusions for the INCO-LAB and INCO-HOUSE projects.

Instrument appraisal:

- Regardless of the type of instrument, common interests and priorities are the main driver for a successful international cooperation programme.

- Bi-regional cooperation projects foster intra-regional harmonisation and create leverage and critical mass.

– ***Best practices and lessons learned:***

- The network approach helps smooth out the 'asymmetry' in the scientific capacity of partners.

- To be successful, both top-down (global goals and shared targets) and bottom-up approaches (demand-driven research) are required.

- The participation/engagement in an international cooperation project increases when there are targeted incentives and competent facilitators (one from each region).

– ***Synergies with other funding schemes and instruments:***

There is definitely room for various types of synergies, although these can vary among the different regions. The existing opportunities are often insufficiently exploited because of a lack of information and redundancies between programmes and projects funded by different instruments. Such opportunities exist for international cooperation projects under the FP7 Capacities Programme and with initiatives funded by other regional and international organisations such as the United Nations Development Programme (UNDP), the World Bank or the European Investment Bank (EIB), but also for EU funding instruments such as the European Development Fund and the European Neighbourhood Partnership Instrument. Examples of areas of synergy include: collaboration between projects; clustering of actions; inter-sectoral education/training activities; use of study sites; joint publications; back-to-back events; better use of ongoing and past project results; results for policy advice; curriculum development; development/access to joint research infrastructures.

The overall evaluation of the instruments used to implement the international cooperation activities under the FP7 Capacities Specific Programme is positive. However, it was noticed that the number of current funding modalities is rather high, so could be reduced — as a transition to Horizon 2020 — by consolidating the current instruments in a smaller set.

2.2.2 e-Infrastructures

The development of e-Infrastructures has an inherent international collaboration dimension. It supports European research by providing the facilities needed to carry out world-class science through the collaboration of research teams, regardless of their country and geographic location. These facilities include high performance computational and communication resources together with the access to remote instruments and large data-sets. These global e-Infrastructures constitute a key element of a seamless digital European Research Area open to the rest of the world and provide a decisive contribution to tackle global research challenges.

The broadband capacity offered by e-Infrastructures constitutes an important enabler for development and through their contribution to the Millennium Development Goals[6] they support the Union's external policies. In reality, e-infrastructures in developing countries go beyond supporting research capabilities and engaging these countries in collaborative work with European researchers, by also creating pools of expertise and promoting intra-regional research collaboration. They also support many other services of general interest (education, health, resources management, disaster prevention, etc.).

E-Infrastructures allow the Union's researchers to reach their peers around the world and explore the scientific resources made accessible in many ways. To achieve this it is necessary to develop international cooperation activities supporting the global reach and interoperability of these e-Infrastructures, such as:

– *Development and interconnection of research and education networks* (e.g. synchronised capacity building, technology alignment and standardisation of communication protocols) and interoperability of services (bandwidth reservation, security, roaming, authentication and authorisation etc). For example, FP7 co-finances (25% of cost) the ORIENT+ link connecting GÉANT to Beijing through Russia.

– *Open and interoperable* scientific *data infrastructures* across countries and disciplines to drive 'data-driven science', exploiting the vast amount of observational, sensor, streaming and experimental data in every field of science[7]. For example, following a coordinated call for proposals with NSF, an international forum for scientific data access and interoperability will be set up with the US, Canada and Australia.

– *Computational infrastructure,* through the standardisation and interoperability of Grid and Cloud computing technologies. Cooperation in this area is both with developing countries and the US and several projects have been funded to support it.

In addition to international cooperation activities focused on technical goals, it is worth mentioning activities geared by the need to establish common principles for global governance. An example of this is the discussions with the OCI (Office of Cyber-Infrastructure) of NSF to establish with Japan, Canada, China and India a network of funders of research and education networks.

Regarding the role played by e-infrastructures in support of development and cooperation policies in developing regions this is an on-going effort being pursued for more than 10 years. During this period about EUR 100 million of aid to development and cooperation have been mobilised to fund research and education networks in Latin America, Central and South East Asia, Africa and in the Mediterranean, and ensuring their connection to Europe.

Examples of active projects involving this orientation are AfricaConnect, RedCLARA, EUMedConnect, TEIN, and CAREN. The prioritisation of these projects has been the object of political endorsement in meetings between the Union and third countries or regions, e.g. by the Africa - EU Summit in 2010 in the case of AfricaConnect or by the EU-Latin America summit in Spain in 2011 in the case of RedCLARA

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6 UN Broadband Commission – Final Report of the Working Group on Broadband and Science

7 "Riding the wave" High Level Expert Group on Scientific Data

The following table provides an overview of the on-going international cooperation activities being undertaken in the context of e-Infrastructures:

International Partners	Areas of cooperation
USA, CANADA	– Global connectivity (interoperability, protocols) – Data Web Forum/Data Access and Interoperability Task Force (DWF/DAITF) – Coordinated Calls (on data with NSF)
Russia, Eastern Partnership	– E-Infrastructure Working Group (addresses mainly networks, data and grids) – Connectivity and support to RENs (HP-SEE, ORIENT link to China through Russia)
Asia	– Connectivity and support to RENs (CAREN, TEIN, ORIENT – link to China, links to India) – Cooperation with India and China in the context of cooperation on research infrastructure (with RTD)
Latin America	– Connectivity and support to RENs (RedCLARA) – Grids/Clouds and services deployment – Coordinated Calls (on data and Clouds with Brazil)
Southern Partnership (MED) and Arab countries	– Connectivity and support to RENs (EUMEDCONNECT, ASREN) – Grids/Clouds and services deployment
Africa Caribbean and Pacific (ACP)	– Connectivity and support to RENs (AfricaConnect, Ubuntunet, WACREN) – Follow-up of C@ribnet – Support to feasibility study for the Pacific RENs
Other developed countries (Japan, Australia, NZ,..)	– Connectivity – DWF/DAITF
International Organisations/Fora	– Global Governance in Data (Chair of the G8+5 GSO group)

	– ITU/UN Broadband Commission (WG on Broadband and Science)

2.3 The Joint Research Centre

As the Commission's in-house science service, the Joint Research Centre's (JRC) mission is to provide Union policies with independent, evidence-based scientific and technical support throughout the whole policy cycle. The JRC addresses key societal challenges while stimulating innovation by developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

To tackle challenges of a global nature, the JRC works with international partners, such as United Nation bodies (e.g. International Atomic Energy Agency, the United Nations Environment Programme, the United Nations Economic Commission for Europe), national research institutes (e.g. the National Institute for Standards and Technologies) and standardisation bodies (e.g. the European Committee for Standardisation — CEN, the International Organisation for Standardisation — ISO, the Organisation for Economic Cooperation and Development — OECD), on the development and assessment of methods, on developing international standards and on harmonised measurement technologies.

The highest number of non-binding bilateral arrangements — about one third of the total — is with **US partners**:

– *NIST (National Institute for Standards and Technology)*: the JRC and NIST have agreed to prioritise standards in energy and transport, and emerging technologies (nanotechnology) as topics for cooperation. Furthermore, the JRC is drafting together with NIST an umbrella arrangement also covering the three existing areas of collaboration (reference materials, security, safety and citizen protection, and marine optical radiometry in support of remote sensing). A joint JRC-NIST seminar on standards for e-mobility is planned for 2012. E-mobility is a key issue for the Trans-Atlantic Economic Council (TEC).

– *AAAS (American Association for the Advancement of Science)*: the JRC and NIST organised a roundtable entitled 'Building a Trans-Atlantic Scientific Bridge' in November 2011, to discuss the clean energy and mobility revolution and to enhance links between European and US scientists, in order to identify synergies and partnerships in support of policy-making.

– *NOAA (National Oceanic and Atmospheric Administration)*: an implementing arrangement was signed in May 2012 between JRC and NOAA. Cooperation will focus in the near term on the following four topics: climate data records, space weather, tsunami modelling, and fisheries research. A joint event, 'Workshop on Opportunities for Transatlantic Cooperation in the Field of Space and Climate Change', was held in March 2011.

– ***National Nuclear Security Agency (NNSA):*** there has been an increased collaboration to prepare for the nuclear security summit in April 2012 in Seoul, and to take into account developments in Japan.

– In the nuclear field, there are two arrangements between **Euratom and the *US Department of Energy*,** one on nuclear energy and one on nuclear security, and there is another between Euratom and the ***Nuclear Regulatory Commission***.

Brazilian partners have six bilateral arrangements with the JRC, on environmental and crop monitoring, soil mapping, life-cycle analysis, and metrology in chemistry. Another is under preparation on sustainable agriculture. Under the EU-Brazil sectoral dialogue on flood forecasting and monitoring, two Brazilian scientists from Brazil's ***National Centre of Natural Disasters Monitoring and Alert (CEMADEN)*** were trained in JRC-Ispra in March and April 2012, to gain experience in flood forecasting and monitoring of soil moisture using remote sensing. This is one of the concrete results of the Letter of Intent signed between the JRC and the ***Brazilian Ministry of Science, Technology and Innovation (MCTI)*** in October 2011 during the 5th EU-Brazil Summit.

JRC has has nine bilateral arrangements with **Japanese partners**, mainly concerning energy. Additionally, the JRC has an agreement with the ***JAEA (Japanese Atomic Energy Agency)*** on nuclear safeguards and security; and with ***CRIEPI (Central Research Institute of the Electric Power Industry)*** on advanced fuel processing.

JRC has provided support to Japan after the 2011 disaster:

– Collaboration in the area of standards for nuclear safety; measurement of radioactivity in food, water, and the environment; development of joint projects between the JRC and the JAEA in the area of safeguards (stress tests), security and non-proliferation under the 2006 Euratom-Japan agreement.

– The JRC has developed the 'Global Alert and Coordination System' (GDACS) jointly with the UN and is developing a 'Tsunami Alerting Device' with Japan that can be connected to Early Warning Systems.

– There is continuing collaboration between JRC-ELSA (European Laboratory for Structural Assessments) and the Building Research Institute of the Japanese Ministry for Construction.

With **Chinese partners**, the JRC has 12 bilateral arrangements, on crop forecasting, life-cycle analysis, and the peaceful use of nuclear energy. In 2010 three agreements were signed, one on a global soil map, one on telecommunications, and one on nanotechnology and alternative methods to animal testing.

Priority objectives and actions:

– The JRC participates in the EU-China task forces on food, agriculture and biotechnology and innovation.

– As a follow-up to the Memorandum of Understanding (MoU) on nanotechnology, a joint event was held with ***CAIQ (Chinese Academy of Inspection and Quarantine)*** on safety evaluations for nanotechnology in April 2011 in China.

– Climate change and clean transport: JRC together with DG CLIMA sent a modelling expert as part of its collaboration with China.

– The ***Chinese Ministry of Science and Technology (MOST)*** accepted the JRC's proposal during the first meeting of the China-EU Steering Committee on Peaceful Use of Nuclear Energy (PUNE) in March 2011 to exchange experience on the safety assessments of nuclear power plants in the Union and China; to exchange information on the analysis of nuclear incidents in the Union and China; and to work together to ensure that all new nuclear plants are based on the best available techniques and comply with the highest nuclear safety and security standards.

With regard to **India,** a bilateral arrangement is in preparation with the ***Indian Council of Scientific and Industrial Research (CSIR)*** to coordinate research activities of common interest. An agreement on PUNE is close to conclusion.

The JRC has long-standing relations with **Africa**, e.g. with the ***African Union Commission (AUC)***, with academia and with national administrations. The African Union and the Union work in partnership on a range of important issues under the 2007 Joint Africa-EU Strategy (JAES) partnerships.

With **Russia**, an MoU on nuclear data exchange during emergencies is under preparation between the Russian Federation and the JRC. Additional contacts will take place on nuclear safety. Under the EU-Russia Common Spaces, areas relevant to the JRC include collaboration between standardisation bodies to prevent technical barriers to trade in numerous domains and the preparation of a cooperation agreement on Global Satellite Navigation Systems.

The JRC has six (including two draft) arrangements with **UN** bodies, covering: open-source monitoring for situation awareness; industrial accident prevention within developing countries; fuel-cell testing; simulation and related educational activities; an information management platform with the ***World Food Programme (WFP)*** and the ***Food and Agriculture Organisation (FAO)***; and environmentally sustainable development of the planet, with special focus on developing countries. UN bodies involved include the ***United Nations Environment Programme (UNEP)***, the ***United Nations Industrial Development Organisation (UNIDO)***, and the ***United Nations Office in Vienna***.

The ***IAEA*** has particular importance for the JRC. There is a separate arrangement between the European Atomic Energy Community and the IAEA, under which the JRC provides training to nuclear inspectors, as well as a draft arrangement with IAEA regarding nuclear security.

2.4 Scientific and Technological Agreements with third countries

The Union has concluded 20[8] Scientific and Technological Cooperation Agreements with third countries under the Treaty on the Functioning of the European Union (TFEU) and with 15 under the Euratom Treaty. These agreements offer a political, legal and administrative framework for coordinating and facilitating international cooperation in research and innovation between European entities and international partners.

The Scientific and Technological Cooperation Agreements were concluded on the basis of Article 186 TFEU. The majority were concluded for an initial period of five years and were tacitly renewed based on the results of an evaluation carried out by external experts during the

8 The agreement with Algeria is provisionally applicable; it will enter into force once the parties have ratified it.

penultimate year of each successive five-year period. Certain agreements are concluded for an indefinite period of time (Australia, Jordan, Canada), while a number are tacitly renewed with every new framework programme.

Although their content may slightly differ, the agreements share some common elements:

- Scope and principles: definition of the areas of mutual interest, reciprocal access to the activities of the research programmes of each party, protection of intellectual property rights, researcher mobility.

- Forms of cooperation: participation and funding in research programmes, exchange of information, coordinated actions, dissemination and use of results and information, implementing arrangements for coordinated calls.

- Management and coordination: designation of a Joint/Steering Committee and definition of its functions, costs incurred by the parties in the coordination of research activities, etc.

	S&T AGREEMENTS CONCLUDED WITH THIRD COUNTRIES		
	Country	**Entry into force**	**Observations**
1	Argentina	28 May 2001	Next renewal on 28.05.2016.
2	Australia	25 July 1994	Duration of the agreement not limited in the time.
3	Algeria	Ratification pending	Provisionally applicable since March 2012.
4	Brazil	7 August 2007	The renewal of this agreement is ongoing.
5	Canada	27 February 1996	Duration of the agreement not limited in the time.
6	Chile	10 January 2007	Next renewal on 10.01.2017
7	China	14 December 1999	Next renewal on 9.12.2014
8	Egypt	27 February 2008	Duration of the agreement not limited in the time.
9	India	14 October 2002	Next renewal on 17.05.2015
10	Japan	29 March 2011	This agreement is concluded for five years and continues to be in force unless terminated by either party.
11	Jordan	29 March 2011	Duration of the agreement not limited in the time.
12	Korea	29 March 2007	This agreement is concluded for five years and continues to be in force unless terminated by either party.
13	Mexico	13 June 2005	Next renewal on 13.06.2015
14	Morocco	14 March 2005	Every four years the parties will evaluate the impact of the Agreement on their scientific and technical cooperation.
15	New Zealand	30 January 2009	This Agreement will remain in force for an initial period of five years.
16	Russia	10 May 2001	Next renewal on 20/02/2014
17	South Africa	11 November 1997	This Agreement is concluded for the duration of the Fourth Framework Programme and will be renewable by agreement between the parties for the subsequent framework programmes.

18	Tunisia	13 April 2004	Every four years the parties will evaluate the impact of the Agreement on their scientific and technical cooperation.
19	Ukraine	11 February 2003	Next renewal on 21.12.2016.
20	United States	14 October 1998	Next renewal on 14.10.2013.

The agreements are reviewed on a regular basis. In general, the experts conducting the evaluations believe that the agreements offer a good opportunity for cooperation in research. In the latest review of the EU-Chile S&T Cooperation Agreement for instance, the agreement was seen to have contributed to fruitful cooperation between the parties, which probably would not have happened to the same extent without the agreement.

As concerns the Steering/Joint Committees, the evaluations note that updating roadmaps adds substance and gives guidance for all cooperation areas and instruments. However, more priority setting and focusing of resources, clearly set out in the annual roadmaps, would improve cooperation. In addition, more systematic examination of the impacts of relevant developments or pilot activities would add an extra dimension to the work of the Committees. Committees normally meet once a year either in Brussels or in the third-country capital.

In representing the Union externally in the field of research and innovation, the Commission also plays an important role in cooperation with other regions in the world. There are currently six bi-regional dialogues and all have a Joint Committee that meets annually:

– EU-ASEAN Senior Officials Meeting (SOM): with the member countries of the Association of South-East Asian Nations (ASEAN);

– Eastern Partnership: with Belarus, Armenia, Azerbaijan, Georgia, Moldova and Ukraine;

– Western Balkan Platform;

– EU-African Union JEG8 (Joint Expert Group);

– Monitoring Committee of the Union for the Mediterranean;

– EU-Africa STI SOM;

– EU-Latin American Countries (LAC) SOM.

Research and innovation are also often important elements of other instruments of Union external policy such as the Partnerships and Cooperation Agreements (PCAs), the Association and Cooperation Agreements, and the Stabilisation and Association Agreements.

2.5 The Union's external financing instruments

In line with the specific treaty provisions laid down in Part Five of the TFEU, the Union's external action shall be guided by the principles pursuant to Article 21 TEU, which include the support for democracy, rule of law and human rights as well as the strengthening of international security, fostering the sustainable development of developing countries, including the achievement of the Millennium Development Goals and to a post-2015 international development agenda, demonstrating solidarity with people facing man-made or natural disasters. Moreover, in the implementation of its external policies, the Union shall respect the external aspects of its internal policies. A set of external financing instruments supports the Union's external policies under the current Multiannual Financial Framework. These include in particular:

– the Instrument for Pre-accession (IPA), targeting the enlargement countries;

– the European Neighbourhood Policy Instrument (ENPI), to support the countries of the European Neighbourhood;

– the Partnership Instrument (PI), to support cooperation with the industrialised countries;

– the Development Cooperation Instrument (DCI) and European Development Fund (EDF), which provide support to the developing countries;

– the Humanitarian Aid and Civil Protection instruments.

While the Union's research and innovation funding aims to support excellence, including through cooperation with third-country partners, complementary support is possible through the external financing instruments, notably to build up research and innovation capacity in countries targeted by the aforementioned instruments. This can involve building up local infrastructure, providing financial support to projects tackling local societal challenges, and stimulating intra-regional cooperation.

Funding from the IPA has thus been used by many of the enlargement countries to cover part of the contribution these countries make to the Union budget under their association with the Framework Programme.

Other examples are the two successive ACP (African, Caribbean and Pacific) *Science and Technology Programmes* funded with EUR 35 million and EUR 23 million from the 9th and 10th EDF, respectively. These programmes aim to help achieve the Millennium Development Goals by enhancing collaborative research and innovation capacity, development, and innovation in the ACP. The thematic focus is on agriculture and agro-industry, energy, health care, the environment, and transport.

In parallel, the *ACP Research for Sustainable Development Programme* (EUR 20 million, from the 10th EDF) is divided into African, Caribbean and Pacific components, with the African component (EUR 15 million) being implemented through the African Union Commission. The aim of the programme is to support research activities contributing to the sustainable development of the ACP and to enhance the capacity of the three ACP regions to implement and monitor their own collaborative research programmes.

Besides these dedicated research and research capacity programmes, further support is provided by IPA, ENPI, DCI and EDF through national and regional programmes and through the DCI's thematic budget lines. For instance, EUR 220 million (25% of the 2007-2010 allocation) for the *Food Security Thematic Programme* went into research and innovation.

In addition, around EUR 60 million have been provided from the 9th and 10th EDF to support capacity building for the use of space technology in Africa and EUR 12 million to support internet connectivity in Africa.

3. INTERNATIONAL COOPERATION ACTIVITIES OF THE MEMBER STATES

3.1 Member States' policies and programmes

3.1.1 Introduction

Member States are actively pursuing activities for the internationalisation of research and innovation. Some have developed coherent internationalisation strategies bringing all activities under the umbrella of a set of common objectives. Others have developed strategies for certain key countries, sometimes building on rather elaborate instruments (such as bibliometric or co-patent analysis, expert group recommendations, cluster analysis)[9]. However, the involvement of Member States in international cooperation in research and innovation differs considerably across the Union[10].

All key indicators show an increase in international cooperation activities in the last two decades. Countries with a high R&D intensity (GERD above the Union average, such as Finland, Sweden, Denmark, Austria and Germany) generally invest more in international activities. These are also the countries that rank highly in the Innovation Union Scoreboard[11]. The measures taken to stimulate business R&D activities are another key factor that also drives research and innovation internationalisation.

3.1.2 Objectives and goals of internationalisation

In contrast to the different strategic approaches[12], the objectives of Member States are rather similar. The quest for **excellence and competence** is in general the major objective. Getting access to advanced knowledge is seen as the central goal in pushing forward with internationalisation.

Gaining **access to new markets, talent and human resources** is also a key objective. Strengthening competitiveness by absorbing know-how and talent on a global scale is seen as necessary to cope successfully with global challenges. The issue of human resources plays a central role: getting access to know-how or markets via talented researchers has become a top criterion even for business investments[13].

Coping with **global challenges** through international cooperation is another central objective, for instance in the areas of climate change, food security, sustainable development, energy supply, health and security. Internationalisation strategies also include cooperation with developing countries.

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9 Good examples for specific country approaches are the China strategies of e.g. France and Germany or Finland's USA action plan.

10 For an overview and more details see http://ec.europa.eu/research/iscp/pdf/drivers_sti.pdf (referred to as 'Drivers Study').

11 See Innovation Union Scoreboard 2012, http://ec.europa.eu/enterprise/policies/innovation/files/ius-2011_en.pdf , p. 7.

12 For a good overview, see Figure 2 of the above-mentioned 'Drivers Study' and chapter 4.2.

13 See e.g. OECD, The Internationalisation of Business R&D, 2008.

Historical and geographical roots play an important role in selecting partners. Strengthening cultural, historical and linguistic ties is still a strong motive for internationalisation. In addition to these cultural or historical factors, cooperation with the BRICS country group (Brazil, Russia, India, China, South Africa) has become a priority for nearly all European countries: China and India in particular are of strategic importance for most Member States.

However, the patterns of research and innovation cooperation show that researchers have their own priorities, values and networks. Most international activities are undertaken bottom-up and prioritise partners in the highly industrialised countries. Cooperation with researchers in industrialised countries — especially with US partners — is favoured by most European researchers[14].

3.1.3 Instruments and measures of internationalisation

Member States use a variety of measures and instruments to strengthen research and innovation internationalisation[15]. These range from preparatory measures and **small-scale funding** for individual mobility, exploratory visits or brokerage missions to the establishment of **off-shore units** and **joint institutes** with a third country. These institutional settings often function as bridgeheads for bilateral cooperation and are linked to business activities and enterprises. Joint institutions may serve as hubs for the exchange of know-how and people. A recent trend is the use of internationally open calls by national funding agencies, or the launch of joint calls by research ministries and ministries in charge of foreign affairs.

Joint funding mechanisms and joint programmes with third countries play a key role as well. These programmes often address specific areas of common interest or target specific technology fields, integrating researchers from both sides in the decision-making processes as well as in the research activities. The integration of private partners (enterprises, SMEs, etc.) supports the development and application of new technologies in new environments.

Science & technology agreements are still used as an instrument to establish a framework for bilateral collaboration, even if some countries (such as the UK) generally do not define their priorities within this context. Especially for smaller Member States, and the more recent Member States, S&T agreements are an additional measure to facilitate access by domestic researchers to complementary expertise and to promote exchange. Within Europe, however, and in relation to neighbouring countries, S&T agreements have lost much of their significance[16].

3.1.4 Thematic priorities

Various reports underline that thematic prioritisation takes place, but that it is broadly defined, mentioning areas such as reliable energy supply, sustainable development or health. Internationalisation strategies often do not go beyond this level. Bilateral calls and funding mechanisms, however, often specify the areas of mutual interest. In agreements with Brazil, research on bio-fuels is mentioned by several Member States. Cooperation with China often

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[14] Competitiveness through internationalisation — Evaluation of the means and mechanisms for promoting internationalisation in technology programmes, ed. TEKES, Helsinki 2004, p. 35, http://www.tekes.fi/en/documents/43275/competitiveness_through_internationalisation.pdf.

[15] For detailed information, see 'Drivers Study', chapter 4.5 Policy instruments.

[16] See 'Drivers Study', chapter 4.5.

focuses on health/biotechnology, nanotechnology/material sciences and ICT. Cooperation with India covers biotechnology, pharmaceutical research, ICT and research related to food and water. For the African countries, health issues — infectious diseases and public health — are highly prioritised. Other areas are environment-related research (water technologies/ management of water resources) and biodiversity.

3.1.5 Member State action to support the internationalisation of business R & D

The internationalisation of business R&D has an internal and an external dimension. Attracting business R&D investment is often a key objective of internationalisation strategies, at which some Member States are quite successful. In Ireland and Hungary, more than two thirds of business R&D comes from foreign affiliates, while in Belgium the figure is nearly 60 % and in Sweden and the Czech Republic around 50 %[17].

Business internationalisation is often supported by institutional arrangements. France and India, for example, have founded the Indo-French Centre for the Promotion of Advanced Research as a joint venture in New Delhi. Germany and India opened a joint Indo-German Science and Technology Centre in New Delhi in 2008 with the explicit goal of strengthening bilateral business cooperation. Several Member States have opened Innovation Houses or innovation hubs to support the internationalisation of their firms. China and the USA especially, but also Brazil and Singapore, are target countries for these ambitions.

3.2 Strategic Forum for International Science and Technology Cooperation (SFIC)

3.2.1 History

In 2008, the Commission adopted the Communication ‘A Strategic European Framework for International Science and Technology Cooperation’[18] with the objective of strengthening science and technology cooperation with non-EU countries. The Communication expressed the need for a strategy at European level to overcome the duplication of efforts by Member States and the Commission to engage with third countries, resulting in a waste of resources and sub-optimal impact. A strong partnership between the Member States and the Commission would be at the core of a strategy to define priorities for cooperation with third countries, based on common interest and mutual benefit, and to pursue these in a coherent way.

The Competitiveness Council of 2 December 2008[19] invited the Member States and the Commission to form a European partnership in the field of international scientific and technological cooperation and to establish a Strategic Forum for International Science and Technology Cooperation (SFIC)[20] to drive forward this partnership.

In May 2010[21], the Council acknowledged the progress made by the SFIC in developing the European partnership and pilot initiatives on cooperation with selected third countries. The

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17 Here referred to as Foreign Direct Investments in R&D; for details see OECD, Internationalisation of Business R&D.

18 COM(2008) 588.

19 Council Conclusions 16763/08.

20 http://www.consilium.europa.eu/policies/era/sfic http://ec.europa.eu/research/era/areas/cooperation/sfic_en.html.

21 Council Conclusions 11032/11.

Council invited Member States and the Commission to consider supporting implementation of the pilot initiatives, to build upon these initiatives when developing a future European strategy for international cooperation, and to work towards coordinated positions on research-related topics in international summits and fora.

Commitment 31[22] of the Innovation Union Flagship[23] recalls that the Union and its Member States should treat scientific cooperation with third countries as an issue of common concern and develop common approaches.

3.2.2 Mandate and structure of the SFIC

The Council gave the SFIC the following mandate:

'To facilitate the further development, implementation and monitoring of the international dimension of ERA by the sharing of information and consultation between the partners (Member States and the Commission) with a view to identifying common priorities which could lead to coordinated or joint initiatives, and coordinating activities and positions vis-à-vis third countries and within international fora.'

The SFIC is composed of two representatives of each Member State and the Commission. Associated Countries participate as observers. The General Secretariat of the Council provides the SFIC secretariat and the Chair and Vice-Chair are elected from Member State delegates. A taskforce composed of voluntary SFIC members and observers assists the Chair in the preparation of plenary meetings. The Commission provides the secretariat for the taskforce. The SFIC develops two-yearly work programmes and reports annually to the Council and the Commission.

3.2.3 Achievements

India initiative

In 2009 the SFIC chose India for a pilot initiative. A technical group was set up to develop the India initiative, which in the first instance focused on water-related challenges. In November 2010, a conference was organised in New Delhi with the Indian Department of Science and Technology. The results of the conference provided input for the development of a strategic research and innovation agenda (SRIA). In June 2011 a joint EU/MS awareness-raising campaign was launched in India by the Science Counsellors in Delhi.

During preparation of the SRIA, it was expanded to cover bioresources, energy, health and ICT. The SRIA is strongly coordinated with other EU/MS initiatives in the thematic areas addressed. The SRIA was transmitted to the Indian government in November 2011. A joint declaration on research and innovation was signed at the EU-India Summit of 10 February 2012 and a large stakeholder event and a ministerial meeting were held in Brussels on 31 May and 1 June 2012 to officially promote the SRIA.

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22 http://i3s.ec.europa.eu/commitment/35.html.

23 COM(2010) 546.

USA initiative

In 2010 the SFIC selected the USA for a pilot initiative on an industrialised country. A questionnaire collected information about SFIC members' and observers' cooperation with the USA and a report summarising the results was produced[24].

In October 2011 a workshop on EU/MS-USA cooperation was organised. In December 2011 SFIC delegates participated in a conference under the auspices of the Polish Presidency in Washington on enhancing EU/MS-USA collaboration. The SFIC was also involved in the first 'Destination Europe' conference in January 2012 in Boston.

These activities resulted in a concept paper for the USA initiative roadmap, which was discussed in the SFIC plenary in March 2012 and will be further developed in 2012.

China initiative

The third geographical choice made by the SFIC in 2010 was China. The initial focus was on collecting information about Chinese research and innovation systems, policies and strategies. In 2011 two workshops were organised to improve knowledge of EU/MS activities on research and innovation with China, identify policy priorities and understand the possibilities for cooperation with China. Based on their outcome, a rolling roadmap for the development of an EU/MS-China strategic research and innovation agenda (SRIA) has been established. In March 2012 the SFIC agreed on a first set of thematic areas — energy, urbanisation, health, ICT — on which to develop an SRIA.

Bi-regional relations

In 2009 a strategic approach to multilateral and bi-regional research cooperation was explored. The SFIC decided to contribute to such initiatives through the appropriate channels and defined its role as a platform to facilitate a common European position at an early stage. As a result, the SFIC contributed to the research and innovation aspects of the EU-AU summit in 2010 and the EU-LAC summit in 2011.

3.2.4 Outlook

The second strategic SFIC seminar took place in May 2012. The focus was on: defining the added value of joint European international cooperation; articulating the vision of the SFIC for a European strategy on international research and innovation cooperation; deciding on the main focus areas of the SFIC's forthcoming work; and on evaluation and monitoring mechanisms to assess impact.

The 2011-12 work programme refers to Brazil and Russia as the next geographical priorities to be explored, and the taskforce is preparing for a plenary discussion by the end of the 2012.

For the India initiative, the implementation phase of the SRIA is approaching. The holding of a Senior Official Meeting was announced in the joint EU-India declaration in May 2012.

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24 http://ec.europa.eu/research/era/pdf/report-on-sfic-questionnaire_en.pdf

The USA and China initiatives should move towards strategic research and innovation agendas building on existing EU/MS thematic initiatives and the experience gained from the India pilot.

In developing SFIC initiatives, interaction with other ERA groups, Science Counsellors of the Commission in third countries, stakeholders and other European initiatives will be actively pursued to ensure European coherence.

4. INTERNATIONAL COOPERATION ACTIVITIES OF THIRD COUNTRIES

4.1 Developments on the global scene

Over the last decade, the centre of gravity of world research and innovation has shifted. While the regions bordering the Atlantic Ocean remain a focal area — and will continue to do so — for many disciplines or key technologies, there have been shifts towards greater dominance by Asian countries. However, despite their impressive and growing research and innovation capacities, Japan, South Korea, China, India and other 'Asian Tigers' all approach the West separately, looking for cooperation. For historical, political and economic reasons, they merely share geographical proximity rather than constituting an integrated community.

There has been a tangible increase in collaboration between countries outside the Union, USA and Japan, in what was formerly called the BRICS 'South-South' partnership. However, cooperation between the BRICS themselves or between the BRICS and less developed countries — observable through co-publications for instance — still remains marginal. In many cases, existing collaboration appears to support specific national economic interests (i.e. high-technology equipment exports, access to natural resources) rather than reflect real win-win partnerships.

Countries grouped in regional organisations such as MERCOSUR and ASEAN, which face economic hurdles, are making continuing efforts to better integrate their research and innovation systems. In recent years, Russia and the countries of the Eastern Partnership have been pursuing an active policy of integration with the global community and have singled out Europe as their priority partner for international cooperation in research and higher education.

Many of the developing countries which, until now, were integrated in international research and innovation cooperation primarily in the form of support provided by developed countries, are now asking for their own demands to be taken on board more directly.

During the last decade, interest in international cooperation in research and innovation has grown rapidly in many countries, in terms of visibility, geographical scope and also budgetary size. As an example, Japan, which has historically been relatively self-centred, is modifying its policy and is moving towards openness to foreign partners.

The post-2008 financial and economic crisis has reduced the resources devoted to research and innovation, while at the same time there has been a strong need to stimulate competitiveness to restore weakened national economies. This has considerably influenced the drivers for international cooperation, with great attention now being given to innovation as a catalyst for growth.

4.2 Drivers of international cooperation strategies

As is the case for Europe, the main driver of cooperation activities by third countries is, to improve the quality, scope and critical mass of research and innovation by linking national and international financial and human resources.

The aim is to have access to state-of-the-art knowledge abroad — for instance in Europe — and to attract it back to the home country. Joint research activities are conducted to tackle common challenges. In emerging countries, an additional aim is to build up national capacity.

The common objectives of different third countries are:

– ***Achieving research excellence and improving competitiveness*** (emerging and industrialised economies). In terms of thematic areas of collaboration, there are a limited number of areas that countries seem to select: nanotechnologies, biotechnologies (and life sciences), research related to climate change, physics, big science projects, ICT, and, on a second level, oceanography and medical research.

– ***Attracting human resources***. The advanced countries are mostly in search of excellence and aim to attract human resources. On the other hand, countries such as China, which have seen significant outward mobility, have launched major incentive measures to repatriate researchers who have gone abroad.

– ***Sharing the growing cost of big science research facilities***, e.g. ITER, where, besides the Union, there is support from the USA, Japan, China, India and Russia.

– ***Building research and innovation capacity through people and institutions***. This is especially the case for emerging countries.

– ***Tackling global challenges*** such as climate change, natural disasters, epidemic or pandemic diseases, biodiversity, new energies.

– ***Supporting less developed countries*** by developing research and innovation capacity, often related to global challenges.

– ***Creating good and stable diplomatic relationships*** (e.g. the USA, Russia, Australia).

– ***Creating regional research and innovation cooperation areas*** (e.g. South Africa).

There is no clear pattern as to which of these drivers defines the geographic direction of research and innovation cooperation. Regarding the search for excellence, however, the focus is clearly on establishing cooperation with world-class research and innovation, located mainly in the USA, the Union and, to a lesser degree, Japan.

There are differences between the advanced countries (such Australia, Canada, Japan, US, etc.) and those that are in the process of becoming more internationally connected (such as India or China), or which have significant catching up to do in terms of building or reforming their research and innovation capacity (such as Brazil, Mexico, Russia or South Africa). For the first group, the most common driver is to connect domestic researchers with the best in the world, regardless of location. The second group suffers from brain drain rather than brain gain. Building research and innovation capacities is a way for these countries to attract (back) or retain researchers in the system, and to open up the national system to bring it up to international quality standards.

Development aid research collaboration has a strong synergy with tackling global issues such as fighting infectious diseases and mitigating the effects of climate change. The geographical linkages of collaboration in the field of development aid are mostly influenced by international diplomatic and cultural ties.

4.3 Forms of cooperation

Even in the few countries with an overarching research and innovation internationalisation strategy, the policy on cooperation is mostly a mix of actions and individual measures taken by different actors rather than a well-developed policy mix: administrations directly responsible for research and innovation; public or non-profit organisations tasked with funding of research and innovation; research-performing institutions and academia; multilateral research organisations; enterprises; and clusters. In this respect, in the most advanced and emerging economies, basic and applied research collaboration appears to remain largely researcher-driven.

Regional government plays a growing role in research and innovation internationalisation. Several larger countries (Australia, Brazil, Canada, Mexico, and the USA) — apart from having national policies — now have regional governments actively involved in international cooperation.

International cooperation is supported through many policy instruments, most with a long history. Third countries use bilateral or multilateral S&T agreements. More recently, many countries are opening up national programmes to attract research and innovation investment or the collaboration of foreign public or private research organisations.

5. MULTILATERAL FORA AND INTERNATIONAL ORGANISATIONS

5.1 European intergovernmental research organisations and initiatives

5.1.1 Research as a precursor of European unification

Post-Second World War Europe concentrated on research and innovation cooperation as a means of advancing knowledge and consolidating peace, initially within the continent but then beyond. CERN and COST (Cooperation on Science and Technology) are early examples, which inspired over the next 30 years the blossoming of other world-leading research organisations such as EMBL (European Molecular Biology Laboratory) and ESRF (European Synchrotron Research Facility), which come together under the EIROforum[25] (European Intergovernmental Research Organisations) partnership, as well as initiatives such as EUREKA (launched in 1985). These European intergovernmental research organisations and initiatives are essentially based on Member State/EEA/EFTA membership, but with recent opening to the rest of the world.

These organisations and initiatives together command a significant annual budget, which, without being part of the Union budget, is still European in the sense that each of these

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25 http://www.eiroforum.org.

organisations has to a greater or lesser extent a European vocation beyond that of its members.

Since the intergovernmental character of such research organisations is not easy to duplicate today, more flexible forms of organisation for large- and medium-scale international research organisations are being sought. To this end, a new legal structure called ERIC (European Research Infrastructure Consortium) has been created for research infrastructures involving the collaboration of several Member States and possibly international partners as well. ERICs are not limited to traditional single-location physical infrastructures, but can also be used for e-infrastructures such as GEANT, whose importance is growing.

ITER is an example of an organisation conceived from its inception as global, but which would not have been possible without a strong European core built over the years around EFDA-JET.

5.1.2 Strong Union support for EIROs and European research initiatives

From the early days of the Framework Programme, cooperation links have been forged with several European research organisations. For example, an administrative arrangement was signed between the Commission and CERN in 1985, putting collaboration between the two organisations on a firm footing and according the Commission observer status on the CERN Council. Similarly, since the mid-eighties, the Framework Programmes have funded the networking activities and central administrative costs of COST. Furthermore, the Rules of Participation have been changed since FP6 to recognise international European-interest organisations as special entities, thus facilitating their participation.

Partnership with these organisations and initiatives has grown through the European Research Area initiative. Already in 2003, a statement of intent to strengthen cooperation was signed between the Commission and EIROforum. Following the 2008 ERA initiatives, and the increasing global opening of EIROs, a new generation of arrangements was signed with CERN (2009), EMBL (2011) and EIROforum (2010). The partnership covers a broad range of issues, from fundamental research and future infrastructures to mobility of researchers, science education, the promotion of innovation, the development of European strategic research agendas and global initiatives. A recent example is the collaboration with CERN under FP7 for equipping the Jordan-based international synchrotron facility SESAME with state-of-the-art magnets, thus helping to promote 'peace-through-science' in this troubled part of the world.

Equally important has been the strengthened partnership with EUREKA, of which the Commission is a member, which resulted in the launching of the highly successful EUROSTARS initiative under Article 185 TFEU in FP7, as well as a number of strategically important Joint Technology Initiatives (ARTEMIS, ENIAC) under Article 187 TFEU.

5.2 The Union as a strong partner of global international organisations and multilateral fora and initiatives

A variety of international organisations and multilateral fora address research and innovation issues to a greater or lesser extent. In recent years, this tendency has accelerated, as tackling global challenges is increasingly relying on international cooperation.

The Commission has long-standing cooperation with many UN group organisations, subsidiary agencies and Conventions or Conferences under its auspices. Cooperation with the UN is explicitly recognised in the TFEU.

For example, there is cooperation at both project and policy dialogue level with UNEP on environmental issues and resource efficiency (International Resource Panel), with the WMO on ozone depletion and climate change issues, with WHO on world health issues, including environmental impacts on health, with UNESCO and its subsidiary bodies on a variety of issues, such as ethics in science, cultural heritage or marine science and the sustainable management of the oceans, and with the IAEA and its subsidiary bodies on nuclear safety issues.

DG RTD participates actively in negotiations under the UN Framework Convention on Climate Change (UNFCCC), both in terms of providing policy advice to DG CLIMA as well acting as lead service for the EU Council Expert Group on Climate Science in the Working Party on International Environmental Governance. Equally important is participation in the Intergovernmental Panel on Climate Change, the Intergovernmental Platform on Biodiversity and Ecosystem Services and the work of the UN Convention on Biological Diversity.

There is also strong engagement in various OECD committees (notably the Committee on S&T Policy — CSTP), fora (notably the Global Science Forum — GSF), various working parties (e.g. on nanotechnology and biotechnology), or affiliated organisations such as the International Energy Agency, as well as with OECD specialised services, notably on indicators.

There are also autonomous organisations dealing with important global issues where Union engagement is important, for example the Consultative Group on International Agricultural research (CGIAR) and the Group on Earth Observation (GEO).

Moreover, there are international scientific and technological initiatives where the Commission has a strong presence, notably the Human Frontier Science Programme (HFSP) and Intelligent Manufacturing Systems (IMS).

Issues of research and science governance at global level are becoming increasingly important, and strong engagement is essential. This is already being seen, for example, in the work by the OECD GSF on Scientific Misconduct, or by UNESCO on scientific ethics issues. Particular attention also needs to be paid to global initiatives like that recently launched by the US NSF on a Global Research Council.

Formal agreements (often in the form of MoUs) exist between the Union or the Commission (sometimes in the form of implementing arrangements) and many of these organisations. Research and innovation are sometimes explicitly identified as cooperation fields. Such agreements allow for recognition of the cooperation at the highest political level, and create a framework for structured policy dialogue or joint actions. Many of these organisations participate in actions under the Framework Programme.

Engaging with international organisations, international fora and other global initiatives can be mutually beneficial, but can also be time-consuming. Therefore, careful prioritisation against specific research and innovation objectives, as well as more general Union policy objectives, needs to be carried out on a case-by-case basis. The potential benefits are many: access to truly global fora, often at the highest political level; keeping in touch with the latest thinking and deliberations on global research and innovation issues, and being able to influence agenda setting and the shaping of global research agendas; contributing to their implementation by incorporating parts of them in FP actions; ensuring that the latest scientific information feeds into relevant international negotiation processes; obtaining the necessary scientific advice to develop sectoral policies, such as on climate change; and enhancing the visibility of the Union.

6. MONITORING AND EVALUATION

6.1 Information gathering system

To support the new strategic approach to international cooperation, an enhanced information gathering system is required to provide timely information both to guide the choice of areas and help identify appropriate international partners. This should be distinguished from the information required to monitor and evaluate international cooperation activities and their impact — as discussed in the following section.

In essence the information system will provide:

(i) foresight/horizon scanning to establish the global potential of an area and to identify emerging challenges;

(ii) analysis of the strengths, weaknesses, opportunities and threats (SWOT analysis) for each of the Horizon 2020 challenges and enabling and industrial technologies, in terms of both research potential and market potential;

(ii) country-specific qualitative and quantitative information for charting and analysis of the research and innovation landscape (research & innovation policies, research capacities, programmes, infrastructures, actors, etc.) and other political, social, economic and legal information pertinent to international cooperation.

The enhancement and greater focusing of international cooperation in Horizon 2020 will require foresight/horizon scanning actions to establish cooperation areas with a view to pursuing a global, rather than intra-European, approach. Programme managers will need to consider, over a long-term perspective, where global innovation 'hotspots' are likely to emerge and how this will influence future European research capacity and market prospects.

Information on research capacities and policies in Member States and selected third countries is currently systematically collected under ERAWATCH[26] and 'ERAWATCH International' activities. In future, as indicated in the Communication, increased attention will be paid to the systematic collection of both qualitative and quantitative information on international cooperation as part of the new Research and Innovation Observatory (RIO). This will include, for the first time, the systematic collection of information on the international cooperation actions of the Member States, for which a pilot study is already underway. Data collected on third countries under the Innovation Union Competitiveness (IUC) database will also be further differentiated to give a clearer quantitative picture of trends developing in selected countries.

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26 http://erawatch.jrc.ec.europa.eu.

Another new element in the data and information gathering system will be the systematic inclusion of third countries, where a SWOT-type analysis will be carried out by programme managers to determine areas for cooperation. The assessment of opportunities for enhanced international cooperation in research and innovation will be particularly important. In preparation, action will be taken to establish the basis for internationally comparable analyses and to conduct analyses on selected non-EU countries. This information, together with much of that collected under RIO, will be publically available and will thereby underpin the determination of common priorities and joint actions by the Union and Member States.

6.2 Indicators to measure progress

6.2.1 International cooperation in Horizon 2020

– Number of targeted international cooperation actions and the total budget associated with them;

– Total budget invested by Member States in international cooperation through Horizon 2020;

– Total budget invested by third countries in international cooperation through Horizon 2020;

– Number of projects with participants from third countries and their share of the total number of projects funded through Horizon 2020;

– Number of participants from third countries and the amount of funding they receive from Horizon 2020, and their shares in the total number of Horizon 2020 participants and Horizon 2020 budget.

6.2.2 International cooperation policies and programmes of the Member States and Associated Countries

– Number of joint programmes of Member States and Associated Countries with third countries and the total budget associated with them;

– Investment of Member States and Associated Countries in international cooperation activities coordinated at European level (e.g. through the SFIC).

6.2.3 Internationalisation of research and innovation

Indicators reflecting the internationalisation of research and innovation:

– Scientific co-publications with authors from different countries; growth over time;

– Exchange of researchers, notably between the Union and key third countries; growth over time;

– World map of innovator networks based on co-patent activities between different countries; growth rates over time;

– Overall cross-country flows of business R&D;

– International flows of royalties and licences.