Framework Service Contract Nr -151364-2009 A08-BE

Final Report for the Specific Contract:

"Overview of International Science, Technology and Innovation cooperation between Member States and countries outside the EU and the development of a future monitoring mechanism".

by the ERAWATCH NETWORK ASBL

Prepared by:

Technopolis Group

Wieneke Vullings (project manager)

Patries Boekholt

Jon van Til

Henk Steinz

and

Manchester Institute of Innovation Research

Paul Cunningham

Kieron Flanagan

With support of the ERAWATCH Network ASBL country correspondents

January, 2013

Table of Contents

Introduction

By way of IPTS, on 24 October 2011 DG RTD issued a request for an offer for a specific contract concerning:

"Overview of International Science, Technology and Innovation cooperation between Member States and countries outside the EU and the development of a future monitoring mechanism".

The ERAWATCH Network ASBL is pleased to present herewith the final report. For the purposes of the implementation of this specific contract, Technopolis BV (Amsterdam) acts as the lead partner of the network. Technopolis BV closely works with the Manchester Institute of Innovation Research (MIoIR) and together they form the core team of this study.

This report is structured as follows:

- Chapter 1 Gives a summary of the organisation of the work and methodologies
- Chapter 2 Provides an introduction to the topic 'international cooperation with third countries' of this study
- Chapter 3 Gives an overview of the goals, rationales and targets for international STI cooperation with third countries
- In Chapter 4 the policies and policy implementation are discussed
- Chapter 5 gives an overview of the budgets linked to these policies and instruments
- Chapter 6 briefly gives an overview of some of the identified trends and geographical patterns
- Chapter 7 Deals with the impacts and effects of international STI cooperation policy
- Chapter 8 provides the view of the project team on the future development of a cost-effective and practical methodology for monitoring the implementation of EU Member States' STI cooperation policies with international partner countries.
- Finally, chapter 9 summarises the main conclusions and findings of the study, and provides recommendations.

It is important to note that each chapter in this report provides an overview of the findings in the reviewed countries on the subsequent topics: strategies, policy implementation, budgets, trends, impacts and effects. Although the findings might not be exhaustive, they are based on thorough research performed by a team of country correspondents from the relevant countries, and checked by high-level government officials in those countries. Besides providing a good overview of the current level of STI international cooperation strategies, policies and activities, the purpose of this country review was to get a clear picture on what (type of) data is available in the countries, that can be gathered within a certain timeframe with restricted resources. This information has been useful to draw up conclusions for the European Commission and the SFIC

members about the design of a practical monitoring and implementation system. It has to be taken into account however that to be able to design such a framework it should be very clear what are the objectives of the future monitoring: i.e. what is the specific policy question relating to international STI cooperation? At what level is information sought? Who is/are the relevant audience(s)? and so on. Therefore, the first step towards the development of a new monitoring methodology would be for the Commission (or individual Member States) to decide on the main questions to be answered with this monitoring system.

A number of potential questions can be suggested:

- From the perspective of the Member States, what are gaps in their own international STI cooperation strategies, policies and activities? What should be complementary targets?
- From the perspective of the Member States, what can be learned from the (best or worse) practices in the other MS?
- From the perspective of the European Commission, what are the Member States doing themselves, and where can there be added value for EU action?

Depending on the main questions and sub questions, clear choices can be made on what to monitor, with what indicators.

These, and other recommendations, will be further elaborated at the end of this report.

1.1 Objectives and scope of the study

According to the Technical specifications the objectives of this study are to provide:

- An overview of EU Member States international STI policies and policy implementation;
- An analysis of the evolution and trends in the international STI cooperation policies of EU Member States and their implementation of over the last 10 years;
- Recommendations for a practical and cost effective methodology for monitoring the implementation of EU Member States' STI cooperation policies with international partner countries.

Countries actively pursue STI internationalisation for a wide variety of reasons, and this can differ greatly between larger and smaller countries, countries at different stages of economic development and countries with different geopolitical considerations. An increasing number of EU Member States have an explicit STI internationalisation strategy codified in key policy documents. Generally this is a strategy from the Ministries involved in Science, Technology and Education and Innovation and Industry. A few countries have an overarching STI cooperation strategy, also encompassing thematic policy domains such as Health or Environment. The objective of this study, however, is to focus on cooperation with what the Commission calls 'Third Countries', i.e. non EU member countries. While the Third Country focus is indeed a distinct category, this is

assessed in the context of the overall STI international cooperation activities and strategies. EU Member States' efforts in international cooperation are most often focused on intra-European cooperation and only secondarily on 'Third Country' cooperation[1]. This balance is however shifting and some Member States, particularly the larger ones, are targeting rapidly emerging economies (notably the so-called 'BRICs – Brazil, Russia, India and China). In addition to providing a good 'base-line study' on the topic, the aim is to provide recommendations on how this activity can be better monitored in the future. This report is the third deliverable of this study. Other deliverables are the inception report (first deliverable), the literature review (second deliverable) and the final report (fourth deliverable).

1.2 Methodology and overall approach

The project team has performed a number of major steps to conduct this study:

- A literature study and a preliminary screening of international STI policies covering all EU27 Member States in order to come to a selection of the most active EU countries.
- An in-depth analysis of STI policies, strategies and programmes in the most active Member States based on collation and analysis of documentation, available databases such as ERAWATCH, and interviews in order to describe trends in international STI cooperation.
    - For this analysis the project team consulted the ERAWATCH Correspondents who are responsible for collating data on research and innovation policy for a particular country. They are the persons informed of the available documents, data and know the policy makers in these fields. The EWN correspondents were asked to collate the necessary data, conduct interviews with 3-5 key actors in their country to update the data and to get a better understanding of the objectives of policies, the anticipated impacts and the monitoring and evaluation systems. A template was developed on the basis of which these EWN correspondents provided their input to the main report.
- Following from the identification of the leading actors in STI cooperation among the Member States, the lead agencies in each country were identified and, in (the rare) case the data were available, an analysis made of their budgetary expenditures on STI cooperation programmes. EWN correspondents were also asked to report on available evidence of impacts in their countries and to report on monitoring and evaluation systems in their country reviews.
- Finally, a synthesis of the relevant information from the fieldwork was made to identify trends, develop typologies, analyse (potential) impacts and evaluation systems and prepare practical recommendations for the Member States and the European Commission for the monitoring of international STI cooperation policies.

[1] Path dependency plays a part: some Member States maintain historical links by means of STI cooperation (e.g. the Iberian countries with Latin America, or the UK with Australia, Canada, etc.) or are otherwise influenced by linguistic commonalities.

1.3 Selection of the most active countries

1.3.1 Method for selection

The first request in the technical specification for this study was to conduct a preliminary screening to identify the most active Member States on the basis of STI cooperation expenditure data. As already stated in the proposal, previous studies show that for a majority of EU countries the availability and reliability of these types of quantitative data are at a poor level. Therefore the following additional proxies for identifying the most active countries were proposed:

- The existence of a dedicated formalised (Extra-EU) internationalisation strategy
- Specific identified agency in charge of international cooperation activities
- Strategic partnerships with key third countries, accompanied by significant budgets
- General mobility schemes open to extra-EU countries
- General R&D project schemes open to extra-EU countries
- Percentage share of internationally co-authored S&E articles worldwide
- Preferred partner for STI cooperation by selected third countries

In order to select the most active countries, the STI cooperation characteristics for third countries of all EU27 Member States were screened. First, a background document was prepared with an overview of strategies, policies, assessments of progress and any striking patterns and trends in each Member State. The main sources for this Background Report were the ERAWATCH Country Reports 2010 and draft 2011 Country Reports (if available)[2]. In addition, the country correspondents responsible for the 2010 and 2011 reports were asked to check the findings and provide feedback on it, which almost all of them did.

Furthermore, additional sources were used to check the findings of the ERAWATCH correspondents, both from the perspective inside-out (from EU 27 to third countries) as well as outside-in (from third countries to EU-27).

The main sources used are:

- The ERAWATCH database that gives and overview of key policy documents, strategy papers and instruments as well as updates on progress on ERA-objectives including international STI cooperation
- Specific ERAWATCH studies such as the report 'Monitoring progress towards the ERA' which includes an analysis of international STI and the opening up of programmes and the 2010 and draft 2011 country reports.
- The results/data coming from FP7 INCO-NETs
- Publication and bibliometric literature (see below for a further description)
- Eurostat data (2010) on Inward Foreign Direct Investment as a percentage of GDP – here a slightly different pattern was found with smaller Member States (Luxembourg, Malta, Ireland, Estonia) tending to have higher rankings.

[2] The extracts from these sources have then been sent to the EWN Country Correspondents for verification.

- Eurostat data (2009) on the percentage of GDP financed from abroad – again a mixed pattern was found, the leading countries being Malta, Austria, UK, Ireland, Latvia.
- OECD (2009) data on firms cooperating internationally as a percentage of all firms – data was patchy, but lead players included Finland, Luxembourg, Estonia and Austria.
- OECD (2009) data on foreign students as a percentage of all tertiary enrolment – here the leaders were the UK, Austria, Belgium, France and Germany.
- EURAXESS database, specifically the EURAXESS National Portals, which provide information on key international mobility schemes across the member states but which also includes links with third countries (see: http://ec.europa.eu/euraxess/index.cfm/jobs/nationalPortals).

1.3.2 Most active countries

Based on the information retrieved from the above-mentioned sources, the data was compiled on a number of relevant indicators for each Member State and a scoring system was developed. The scoring system includes the most relevant proxies as mentioned above: e.g. strategy, actors, agreements, instruments and output. Each proxy is associated with a score that ranks the collected data for every member state.

One of the key proxies used is the existence of a formalised internationalisation strategy. The intensity of STI cooperation in a country depends on the actual nature of agreements in place. Successful extra-EU internationalisation policies require a significant amount of relevant bi- or multilateral agreements and sufficient funding in respect to the country size.

Furthermore, the range and importance of target countries in STI cooperation is another indicator for the extent of countries' activities. Therefore the countries' performance regarding these indicators was assessed, taking into account the strategic relevance and the significance of funding allocated to the partnerships. Also, the number of bi- and multilateral agreements was taken into account. An additional indicator used was the extent of instruments and activities aiming at STI cooperation with third countries. Furthermore, the existence of international attachés indicates the extent of networking a country is undertaking.

A country's contribution to internationally co-authored S&E articles that are published worldwide moreover represents a valuable indicator of the significance and internationalisation of its research community. Data from NSF 2010 made it possible to identify two groups of countries regarding their percentage share of internationally co-authored S&E articles worldwide.

Finally, the third country perspective indicator shows whether the country is a 'preferred target partner' for a selected group of third countries/regions.

Based on the total sum of points awarded, each country was attributed a green, orange or red label. Green countries are those with a total amount of points equal to or above 8. Countries that received six or seven points (about average, which is 6.6) were labelled as orange. Red countries received less than six points (below average). The selection criteria are summarised in the following table.

Figure 1 Selection criteria

Label	Threshold (X=scored points)	Number of countries
Green	x ≥ 8	9
Orange	6 or 7	8
Red	X < 6	10

After discussion with the Commission and the SFIC members, the project team suggested to focus on the 9 green labelled countries. In addition to these 9 'most active' countries, three other countries were included in the final selection in order to improve the representativeness of the countries in the study (Austria, Portugal, Slovenia). The selected countries are: Austria (AT), Germany (DE), Denmark (DK), Finland (FI), France (FR), Italy (IT), the Netherlands (NL), Portugal (PT), Slovenia (SI), Spain (SP), Sweden (SE), United Kingdom (UK).

2. International STI cooperation dynamics

Over a number of years, international cooperation has become an increasingly important issue for national and European STI policies. In a previous study[3] it was summarised that this trend was driven by various factors such as the emergence of the BRICS, an increased political debate on global challenges, the globalisation of R&D, general demographic developments and increased policy debate and ambitions in Europe to provide more critical mass and international profile to research excellence. The discussions on the European Research Area (ERA) particularly stimulated more attention to the topic. In addition, internationalisation strategies have become increasingly part of the general STI policies on both national and European and global level. This chapter will provide an overview of the international STI cooperation dynamics as found in the literature on the topic, and based on previous studies performed by the study team on drivers for international STI cooperation. It will furthermore present a structure for analysis of the findings of this study and, in particular, the findings in the country reports. This structure could form the basis for a future monitoring framework for international STI cooperation with third countries.

2.1 The international dimension for the EU

This international dimension is considered to be an important component of the development of the ERA and therefore of the EU's capacity for innovation and competitiveness. In line with these trends, the European Commission (EC) adopted a 'Strategic European Framework for International Science and Technology Cooperation' in 2008 and established (by the Council of the European Union) a new European 'Strategic Forum for International S&T Cooperation' (SFIC) to act as a focal point for the development of a coherent approach to international cooperation and the external dimension of ERA. SFIC is an advisory body to the Council and the Commission with a view to implementing a European Partnership in the field of international scientific and technological cooperation. Member States and the Commission are members of the Forum while countries associated to the 7th Framework Programme have observer status. SFIC's objective is "to facilitate the further development, implementation and monitoring of the international dimension of ERA by the sharing of information and consultation between the partners 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"[4]. SFIC has been working on the symbiosis of the external and internal dimension and has developed a step-by-step approach, starting with a geographic and a thematic pilot initiative on "EU S&T cooperation with and vis-à-vis India" and "energy research (in close coordination with the SET- PLAN)" respectively, i.e. in areas where cooperation between SFIC members could provide added value. Additionally, SFIC is exploring a strategic approach in view of

[3] Drivers of International Cooperation In Research, EC DG Research, 2009. Technopolis Group/ Manchester Institute of Innovation Research

[4] http://www.consilium.europa.eu/policies/era/sfic

multilateral and bi-regional research cooperation. The plan of activities of SFIC is laid down in its work programme 2011/2012.

The EU has developed international STI cooperation policy throughout the last 25 years with an increasing focus on the external dimension, in order to address the needs and opportunities of an interconnected world, and to contribute to peace and prosperity for European citizens. International STI cooperation has provided an important opportunity for the EU to put its expertise to the forefront in meeting its political, social, economic and humanitarian commitments. It has also played a role in the implementation of international agreements to which the EU is a party (e.g. on biodiversity or climate change). In general terms, one can identify the following (not extensive list of) categories of drivers for the EU to involve itself, as a single entity, in international STI cooperation with third countries[5]:

- Support to policy dialogue and priority setting
- Capacity building
- Networking and partnership building
- "Speak with one voice"
- Set common rules and regulations
- Support capabilities in developing countries with more impacts due to opportunities of scale.
- Assessment and monitoring
- Dissemination and outreach

Although the importance of STI cooperation thus has been repeatedly stressed at supra-national, national and institutional policy levels with different motives and foci, there is still reluctance to invest financial resources in global STI undertakings. A recent OECD report[6] on international STI cooperation governance states that "Even within the EU – after six decades of efforts at integration – some 85% of all public research and development (R&D) is programmed, financed, monitored and evaluated at the national level". The authors argue that this reluctance is due to legitimacy issues for national governments: they have difficulties justifying spending money on international cooperation rather than on national research projects. In general, there is little monitoring and therefore limited information of the long-term benefits that can be achieved by international STI cooperation.

This study therefore specifically focuses at the level of the Member States and attempts to a) provide an overview of the EU Member States' international STI policies and policy implementation, b) analyse the evolution and trends in these policies and implementation over the last 10 years and c) provide recommendations for a practical and cost effective methodology for monitoring the implementation of EU Member States' STI cooperation policies with international partner countries.

[5] These categories of benefits are also recently studied in the 'Interim Evaluation of the International Cooperation Activities of the Seventh Framework Programme's Capacities Programme' (Report of the Expert Group, 2012)
[6] OECD DSTI/STP/STIG(2012)

2.2 Policy rationales and targets for international STI cooperation

Our study shows that the literature on the topic of internationalisation in S&T can be broadly split into two broad themes: first, that there is an extraordinarily diverse and distributed literature dealing with what might be called the 'bottom-up' internationalisation of science, that is international collaboration dynamics stemming from the activities of scientists and scientific organisations themselves; and second, a much less extensive literature on public policy towards the internationalisation of science. Drivers and motives for Member States, agencies, HEI institutes and individual researchers to engage in international cooperation and therefore also policies and policy implementation vary to a great extent and they differ according to the specific field of research and target country.

Two broadly different sets of objectives for international STI cooperation have already been distinguished in a previous study: 1) intrinsic objectives, directly aimed toward STI substantiation, such as cooperation among researchers, large-scale infrastructure building, etc; 2) external ones, focusing on the support of other policies such as foreign policies, economic/market policies, development policies, etc.

The focus for certain Member States towards third countries is often based on the co-existence of competences in the respective countries – the relative high focus on BRIC countries and the USA supports this and nearly all countries cooperate with China. Closely linked to diplomatic and historic path dependencies, several countries have a geographical focus on specific regions in the world. Another important factor is geographical proximity.

Based on the previous study by the project team on drivers for international STI cooperation, and based on an updated literature review for the current study, it is possible to identify policy 'rationales' or cause-effect mechanisms and the policy 'targets' that these rationales imply. The project team feels that examining whether international cooperation policies attempt to address these targets could be one important focus for monitoring and evaluation[7]. For this study the rationales and targets are separated out by broad policy goals, namely:

- Achieving research excellence;
- Attracting/retaining/developing human resources for S&T;
- Fostering competitiveness & innovation;
- Science diplomacy (furthering foreign policy goals through the use of S&T);
- S&T capacity building in other countries;
- Tackling grand challenges.

The possible targets thus identified (some of which map onto more than one goal/rationale) are:

- Promotion of publishing in international scientific literature
- Promotion of international research collaboration

[7] See also: Flanagan, K. et al (2012) Internationalisation of Science: dynamics and policies – an updated literature review (second draft). Manchester Institute of Innovation Research.

- Targeting internationalisation policy on promoting collaboration with emerging science powers
- Promoting the inward migration of high quality researchers via international collaboration
- Encouraging and supporting researchers to spend time abroad
- Encouraging and supporting students to spend time abroad
- Promoting university/HEI teaching internationalisation
- Reducing outflows of researchers by improving conditions in the domestic science system
- Attracting back researchers who have left to work in other systems
- Promoting international regulatory or standards-setting collaboration
- Promoting research and technology organisation (RTO) internationalisation
- Improving perceptions of the country by promoting its scientific achievements
- Pursuing foreign policy goals by promoting scientific cooperation and values
- Promoting cooperation which builds capacity in collaborating countries
- Promoting international research cooperation on grand/global challenges
- Avoiding one-size-fits-all approaches

The following table presents the framework of policy goals and targets developed from the literature review. This categorisation of rationales and targets will be used in the remainder of this study.

Figure 2 Goals, rationales and policy targets

Goal	*Underlying rationale or driver*	*Implied policy target or objective*
Achieving research excellence	Citation is an indicator of quality, internationally co-authored papers tend to be more highly cited	Promote collaborations leading to co-authored papers with international partners
	Publication in international (high-impact SCI) journals is an indicator of quality	Promote publication in international scientific literature
	International collaboration is a way of sharing the costs/risks involved in staying at the leading edge research, accessing funding or accessing expertise/data/samples/facility/sites in other countries	Promote international research collaboration
	The geographic division of labour of global science is changing	Target internationalisation policy on emerging science powers
Attracting/ Retaining/ Developing human resources for science & technology	International collaboration is a way of accessing international scientific labour markets	Promote international research collaboration
	International mobility has positive effects upon the subsequent research career of previously mobile researchers	Promote international mobility
	Experience of mobility as a student is a good predictor of future researcherobility	Promote student mobility
	Internationalisation of university/HE teaching is linked with internationalisation of research	Promote university/HE teaching internationalisation
	Countries with poor domestic conditions may risk damaging outflows of talented researchers	Reduce outflows by improving domestic conditions Attract back researchers who have left to work in other systems
	Brain circulation can have positive benefits to the 'sending' system when scientists return	Attract back researchers who have left to work in other systems
Fostering competitiveness & innovation	International collaboration is a way of influencing regulatory regimes or standards	Promote international regulatory or standards-setting collaboration
	RTO (research and technology organisation) internationalisation is a way of accessing a new client/technology base	Promote RTO internationalisation
	The geographical division of labour in global innovation is changing	Promote collaborative links with rising innovation powers
Science diplomacy (furthering foreign policy goals through S&T)	Research and S&T partnerships are means of improving international relations and leveraging 'soft power'	Improve perceptions of country by promoting scientific achievements Pursue foreign policy goals by promoting scientific co- operation and values
S&T capacity building	University internationalisation is a means to building S&T capacity	Promote university research/teaching internationalisation
	Increased capacity building is crucial to ensure that the impacts of research are shared globally	Promote capacity building collaboration
Tackling grand challenges	International collaboration is a way of tackling complex challenges	Promote international research collaboration on grand challenges
	Different problems/challenges and contributing research fields will have their own dynamics	Avoid one-size-fits-all approaches

3. Strategic policy making

This chapter gives an overview of the main objectives and strategies of the selected Member States for STI cooperation with third countries based on the country reports. Secondly, it discusses what these insights imply for a monitoring framework of STI cooperation with third countries. The overview of current practices provides a concise picture of the policy practice, addressing objectives and rationales for setting up and stimulating STI cooperation. Furthermore, an overview of the policy domains involved and the key actors is provided. Lastly, this report provides an overview of specific priorities, such as thematic or geographic priorities. In the second part, the authors will discuss what the insights in the policy practice means for monitoring – presenting entrance points for useful indicators.

3.1 Main findings from the country reports

3.1.1 International STI cooperation strategies

Even the countries that were identified by the 'quick-scan' exercise as the most active in STI cooperation with third countries do not always have an explicit strategy document on this topic at the national or federal policy level. Based on the analysis of the 2010 and 2011 ERAWATCH Country Reports of the EU27 Member States and further fieldwork in those countries, the project team has found a large variety in the extent to which third country STI cooperation is part of national strategy formulation, ranging from countries with strategy formulation specifically for extra-EU cooperation, to countries that attached only a marginal role to international STI cooperation. Some countries have a formalised strategy specifically aimed at international cooperation, but do not distinguish between EU and extra-EU cooperation. These documents deal with cooperation within the EU framework, but also include strategy formulation for extra-EU cooperation. In particular, the smaller Member States tend to have quite a strong focus on cooperation within the EU. In addition, countries with a relatively small budget for international STI cooperation tend to have strong focus on the EU, cooperating in a range of instruments of interest, such as the Framework Programmes, ESFRI, etc.

The absence of a stand-alone strategy document for STI cooperation with third countries does not necessarily imply the absence of activities nor active STI cooperation at other than central policy levels. Nevertheless, it is observed that in countries that do have an overarching strategy, coordination and alignment is stronger.

A first group of countries consists of only the larger countries (DE, FR, IT, UK) which have stand-alone national (or federal) specific strategies for international STI cooperation with third countries. An interesting example of strategy development and implementation exists in the UK, where the Global Science Forum (GSIF) has a cross-governmental communication function, whilst coordination across government on these matters is led from within the Department for Business, Innovation and Skills. On its establishment, GSIF published a strategy for international engagement in R&D and aimed to monitor its implementation. There is thus a "coordinated cross-government strategic approach"[8] towards international cooperation with third countries. In Germany, a rather general strategy document at ministry-level outlines a strategy and acts in a coordinating role. At implementation level, the ministries and agencies have their own, more specific strategies – often in separate documents. In Austria, a national overarching international STI cooperation strategy is under development and is planned to be finished by 2013. A similar process was started in Sweden (with a memorandum on this topic in 2008), but this has not yet led to an implemented strategy document.

A second group of countries have a formalised strategy specifically aimed at international cooperation, but which is not specifically aimed at extra-EU cooperation. These documents often deal quite extensively with cooperation in the EU framework, but also include strategy formulation for extra-EU cooperation. In most cases the countries (i.e. Denmark, Finland, the Netherlands) have a stand-alone strategy document dealing with extra-EU co-operation as part of the 'general' STI cooperation strategy or it is taken up as a separate section – however, the main focus of the document is also geared towards EU cooperation. The strategies are drafted at different levels of governance. In addition to the 'national strategy', implementation agencies, and/or different ministries may have more specific strategy documents – such as the strategy of the Dutch Science Council NWO, which focuses primarily on the attraction of researchers, while the internal strategy of the Ministry for Economy, Agriculture and Innovation is strongly focused on competitiveness.

A third set of countries has addressed international cooperation as an element of their national STI policy document. These strategic documents discuss the main issues and approaches towards internationalisation, but in several cases these strategies are of a general nature and most often do not (yet) focus on extra-EU cooperation (for example in Austria, Spain, Portugal, Slovenia and Sweden). In several countries, there is debate about the need for a strategy (Austria, Sweden). In Austria, for instance, the discussion about a division of tasks form the main motivation for stronger strategic guidance, since responsibilities for STI internationalisation are divided across a range of ministries. Finally, it is reported that Sweden has a strong bottom-up approach, thus a more structured approach might be useful.

3.1.2 Actors and governance

Based on the analysis of the twelve country reports that were written for this study assignment, it became clear that STI cooperation policy is always divided between a number of policy actors, each with its own objectives, rationales and implementation

[8] ERAWATCH Country Report 2011: UK

patterns. Despite the differences in the broader institutional settings, a rather comparable picture emerges across all countries. In Germany, Denmark, Finland and Sweden, a rather general strategy document at ministry-level provides the headlines, which are then worked out more specifically by Science Councils or agencies – often in separate documents. Although Germany gives relatively little weight to international cooperation in its national RDI strategy, it operates an international office for bilateral and multilateral cooperation, which dedicates significant resources to extra-EU internationalisation. In the Netherlands, strategy documents are drafted at the level of agencies, thus specifically focusing on the objectives of that agency – such as a strategy of the Science Council NWO, which focuses primarily on the attraction of researchers.

The default situation is that the ministries responsible for STI (including, science, innovation and economy) have internationalisation in their portfolio. Only Italy deviates from that position as the lead role is shared with the ministry of foreign affairs. In nearly all cases where international cooperation is promoted, innovation and research agencies and science academies play a pivotal role in the implementation of the strategies.

The project team has identified some examples of dedicated agencies or intermediaries that play a pivotal role in the implementation of STI cooperation policies, such as Germany (DAAD) and Denmark (Funding Agency Coordination of International Tasks). Other examples can be found in Austria and Sweden which have specific agencies or foundations responsible for international cooperation in STI, as opposed to other countries and agencies where international cooperation in STI forms only a part of the general STI policy.

Not surprisingly, the country reports revealed that the main drivers and objectives for the ministries responsible for science and research are the intrinsic scientific drivers of striving for excellence and improving the national science system.

Regarding policy implementation, the variation is much larger between countries, involving agencies or councils, depending on the institutional settings of the country.

Another omnipresent rationale is to further the competitive position of the country. In this light, the ministry responsible for innovation is generally involved: here, this is quite often part of the ministry responsible for research or economy.

In a number of countries this also implies the involvement of the ministry responsible for the economy, industry and/or trade (e.g. Austria, Denmark, the Netherlands, Slovenia, Sweden and the UK). In some cases (e.g. Italy, Spain) there is limited coordination between the different departments or ministries, especially when no overarching strategy exists. In other countries the role of the ministries responsible for economy, industry and/or trade is less clear from strategic documents and the interviews. Again, coordination between the responsible actors from the science policy and the economy domain may be low if no coordination mechanisms exist. However, it should be noted that coordination activities may in fact take place, but they are operated at less formalised levels or between departments at the middle policy levels and have not been detected in the analysis by the project team.

Additional rationales presented in the earlier framework of policy goals and targets were science diplomacy, development goals and tackling global challenges[9]. Science diplomacy is embedded in the ministries of foreign affairs – science is a rather universal and value-

[9] This is not an exhaustive list of rationales, rather a crosscutting overview of main rationales is provided.

free issue, so it provides opportunities to make the first diplomatic steps to forge diplomatic relationships. Countries with a colonial past or similar long term historical ties often also cooperate with their former colonies. This type of historical cooperation may have different underlying reasons: development, diplomacy, access to research sites and/or dealing with global challenges. Frequently, this type of cooperation falls under the responsibility of the Ministry of Foreign Affairs or its equivalent. The policy domain of dealing with global challenges is quite visible in countries such as Denmark – in these cases a ministry of, for instance, energy is also involved, together with the research/innovation ministries.

Figure 3 Actors responsible for STI cooperation policy making and implementation

	Research	**Trade and industry**	**Development**	**Sectoral**
AT	Austrian Federal Ministry of Science and Research (BMWF) Federal Ministry of Transport, Innovation and Technology (BMVIT) Federal Ministry of Economy, Family and Youth (BMWFJ) Ministry of Agriculture, Forestry, Environment and Water Management Austrian Science Fund (FWF) Austrian Agency for International Cooperation in Education and Research (OeAD GmbH) Austrian Research Promotion Agency (FFG)	Federal Ministry of Economy, Family and Youth. (BMWFJ) Austrian Research Promotion Agency (FFG) Austrian Business Agency (ABA)	Ministry for European and International Affairs (BMEIA) Austrian Development Agency ADA	Ministry of Agriculture, Forestry, Environment and Water Management AWS
DE	Federal Ministry of Education and Research (BMBF) German Research Foundation (DFG) Federal Foreign Office (Represents German interests abroad, incl. foreign science policy) Länder governments (State level)	Federal Ministry of Economic Cooperation and Development (BMZ) Federal Ministry of Economics and Technology (BMWi)	Federal Ministry of Economic Cooperation and Development (BMZ)	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
DK	Ministry of Science, Innovation and Higher Education Danish Agency for Science, Technology and Innovation (DASTI) (including the Centre for	Danish National Advanced Technology Foundation (DNATF) (Funding)		Ministry of Food, Agriculture and Fisheries Ministry of Climate and Energy
DK	Ministry of Science, Innovation and Higher Education Danish Agency for Science, Technology and Innovation (DASTI)	Danish National Advanced Technology Foundation (DNATF) (Funding)		Ministry of Food, Agriculture and Fisheries Ministry of Climate and Energy

ES	Ministry of Economy and Competitiveness (MINECO) Spanish Research Council (CSIC) Spanish Universities Rectors' Conference (CRUE)	Ministry of Economy and Competitiveness (MINECO) Spanish Centre for Industrial Technological Development (CDTI) Spanish Institute for Foreign Trade (ICEX)	Spanish Agency of Cooperation and Development (AECID) (Of the ministry of Foreign Affairs)	National Institute for the Agriculture and Food Research and Technology (INIA) Carlos III Health Institute Geological Survey of Spain (IGME) CIEMAT (Energy, Environment and Technology)
FI	Research and Innovation Council Ministry of Education and Culture The Academy of Finland	Ministry of Employment and the Economy Tekes, the Finnish Funding Agency for Technology and Innovation		Research and Innovation Council Advisory Board for Sectoral Research
FR	Ministry of Higher Education and Research (MESR) Ministry of Foreign and European Affairs (MAEE) The French National Research Agency (ANR)	The Ministry of the Economy, Industry and Employment (MINEFE) The French National Research Agency (ANR) OSEO Innovation supporting SME R&D and innovation projects	Ministry of Foreign and European Affairs (MAEE)	
IT	Ministry of Education, University and Research (MIUR) *Working Group for the Internationalisation of Research (Advisory)* National Research Council (CNR) (University of Bologna (UniBO)) Emilia-Romagna Region (Sub-national level)	Ministry of Foreign Affairs (MAE) Inter-ministerial Committee for Economic Planning (CIPE) Emilia-Romagna Region (Sub-national level)	Ministry of Foreign Affairs (MAE)	Ministry of Environment, Land and Sea (MATTM) Ministry of Health Ministry of Agricultural, Food and Forestry Policies (MiPAAF) Ministry of Defence National Agency for New Technologies, Energy and Environment (ENEA)
NL	Ministry of Education, Culture & Science NWO (Netherlands Organisation for Scientific Research) KNAW (Royal Netherlands Academy of Arts and Science) VSNU (Association of Dutch Universities)	Ministry of Economic Affairs, Agriculture and Innovation (EL&I) NL Agency (AgentschapNL) EVD (Agency for International Business and Cooperation) Ministry of foreign affairs (foreign trade)	Ministry of Foreign affairs (development cooperation)	Top Sectors: High Tech Material & Systems, Agro-Food, Water, Energy, Horticulture, Chemicals, Creative Industries, Logistics and Life Sciences
PT	Ministry for Education and Science (MEC) Ministry for Foreign Affairs	Ministry for the Economy Innovation Agency (AdI)	Ministry for Foreign Affairs Luso-American Foundation for	Ministry for Agriculture Ministry for Health Ministry for Foreign Affairs

PT	Ministry for Education and Science (MEC) Ministry for Foreign Affairs Science and Technology Foundation Council of Rectors of the Portuguese Universities (CRUP) Foundation for Science and Technology (FCT)	Ministry for the Economy Innovation Agency (AdI)	Ministry for Foreign Affairs Luso-American Foundation for Development (FLAD) (Health)	Ministry for Agriculture Ministry for Health Ministry for Foreign Affairs (Tropical Research Institute (IICT) (State laboratory, which is in the purview of the Ministry for Foreign Affairs))
SI	Ministry of Education, Culture, Science and Sport Slovenian Research Agency	Ministry of Economic Development and Technology	Ministry of Foreign Affairs	(The internationalisation of Slovenian STI cooperation has so far not prioritised specific research fields)
SE	Ministry of Education and Research Swedish Foundation for International Cooperation in Research and Higher Education (STINT) Swedish Foundation for Strategic Research (SSF) Knowledge Foundation (KKS)	Ministry of Enterprise, Energy and Communication Swedish Governmental Agency for Innovation Systems (VINNOVA) Swedish Agency for Growth Policy Analysis (Growth Analysis)	Swedish International Development Agency (SIDA)	Swedish Research Council (VR) (natural and social sciences, medicine and education) Swedish Council for Working Life and Social Science (FAS) (supported by the Ministry of Health and Social Affairs) Swedish Council for Environment, Agricultural Sciences and Spatial Planning (Formas) (funding by Ministry of Sustainable Development and the Ministry of Agriculture, Food and Consumer Affairs) Riksbankens Jubileumsfond (RJ) (humanities and social sciences) Foundation for Strategic Environmental Research (MISTRA) Swedish Foundation for Health Care Sciences and Allergy Research (Vårdal Foundation) The Swedish Energy Agency (SEA) Swedish Space Agency
UK	Department for Business, Innovation and Skills (BIS)	Department for Business, Innovation and Skills (BIS)	Department for International Development (DfID)	Health: Department of Health; Wellcome Trust Agriculture and

Source: country reports

3.1.3 Policy priorities

Depending on the type of actor, policy domain and its related rationales, a number of geographical and thematic priorities can be distinguished for most of the countries.

Geographic priorities

All countries have set geographic priorities that depend largely on the drivers and rationales for putting policy in place for international STI cooperation. The interviews with key actors in the selected countries showed a coherent picture of the major geographical priorities. With regard to *intrinsic STI drivers*, cooperation with nations with a notably excellent STI system has the highest priority in most countries. Therefore, there is geographic focus on nations with a strong STI reputation such as the United States and Japan. Other countries in this category include Canada, Israel and the non-EU Nordic countries. With regard to the Nordic countries, the multilateral Nordic cooperation is an interesting configuration, as it includes both EU and non-EU countries that are within close geographic proximity. In some countries (the Netherlands and Sweden) this orientation is not explicitly written down in strategic documents, but should be perceived as 'obvious' and therefore does not need additional stimuli from policy[10].

In addition to these countries, almost all of the selected Member States tend to target the BRIC countries: Brazil, Russia, India and China. Smaller Member States, in particular, focus their attention on a limited number of countries: Austria puts more focus on Russia and China, while the Netherlands and Portugal put less emphasis on Russia. But nevertheless, a clear shift towards these countries is visible. In addition, a number of Member States are also targeting other emerging economies[11] such as South Africa and Indonesia.

A similar set of countries, i.e. front-runners and emerging economy countries, are also prioritised in relation to *the competitiveness policy rationale*. The same countries that are interesting for their excellence in research are also perceived to provide opportunities for the co-development of innovation, particularly when coupled with large potential markets. The newly emerging economies are even more interesting from the competitiveness argument. While it may take time for the quality and capacity of their research to mature, the strong growth of their economies has made these countries immediately interesting as an emerging market.

Among the Member States that were examined, those with *development* as a policy-goal for STI-cooperation include Austria, Denmark, Germany, France, the Netherlands, Portugal, Sweden and the UK. In this regard the most common geographic priorities are African countries, but may also include developing countries from other continents. The analysed Member States show more variety in their choice of target countries for development goals, which are often based on path dependencies. Such historical path dependencies remain influential in geographical priority-setting, although this is not always demonstrated in strategy documents. Nevertheless, at the level of instruments and actual cooperation, patterns are visible that coincide with historical links.

Policy rationales for cooperation over these historical relations are often intertwined. These may be based on a wide range of aspects such as cultural aspects (including language), accumulated bodies of knowledge, diplomacy, etc. Examples of this are the cooperation of Spain and Portugal with South-American countries, which provides benefits for both scientific and competitiveness purposes while a shared language and

[10] See for instance Country Report of The Netherlands, where this was explicitly stated in several interviews.
[11] Cf. the BRIICS countries

cultural aspects may serve as catalysts for cooperation. Similar patterns are to be observed for France and the UK, and to a lesser extent for Germany with their historical partners. Also, the cooperation of The Netherlands with Indonesia forms an interesting example, where Indonesia is important for research that was accumulated in the Netherlands over the past century; Indonesia may also be seen as an interesting upcoming economy with market potential. Also noteworthy is the strong focus on neighbouring countries amongst the selected Member States at the borders of the EU: Slovenia and Austria notably focus on countries in relative close proximity to the east.

The following figures show the geographical focus of the countries studied towards extra-EU countries based on their reported agreements, instruments and other activities.

Figure 4 Geographical focus of EU-12 under study (non-exhaustive)

Geographical focus of selected EU-12 towards Extra-EU countries based on reported agreements, instruments, etc. (Non-exhaustive).			
Focus of > 7 EU countries:	Focus of at least 5 - 7 EU countries:	Focus of at least 3 / 4 EU countries:	Focus of at least 2 EU countries:
USA, Brazil, India, China	Japan, Russia, South Africa, South Korea, Argentina, Canada, Chile, Indonesia, Israel	Morocco, Serbia, Taiwan, Vietnam, Albania, Egypt, Kenya, Mexico, Saudi Arabia, Singapore, Ukraine, Uzbekistan, Venezuela	Afghanistan, Australia, Colombia, Croatia, Iraq, Kuwait, Macedonia, Moldova, Montenegro, Mozambique, Pakistan, Rwanda, Tunisia, Turkey

Source: country reports

Thematic priorities

At the strategic level, not all the selected Member States demonstrate thematic priorities: thus, Austria, the Netherlands[12], Sweden, Slovenia and the UK do not target specific sectors or thematic challenges. Therefore, with the current information available it is difficult to connect the geographical focus to a thematic priority, if in place.

In the other selected Member States, thematic priorities are defined, often as a result of STI-cooperation strategies embedded in broader strategic directions on STI policy. However, these do not target a particular extra-EU country. While STI policy rationales are the main driver for cooperation, there is often a link towards certain domains or challenges, which is also the case for 'generic' STI policy. Although it is difficult to take an overall view of all thematic priorities addressed in the country reports, due to the different levels of specificity[13], there are only a few directions that countries pursue. These

[12] In the Netherlands, the main documents are still written in an horizontal perspective while 9 selected hot spots (or "Top Sectors") will be the main thematic areas at present

[13] E.g Cleantech versus Environmental technologies versus sustainable development

directions are either framed as 'challenges' or as 'technological growth areas' that often imply certain sectors/markets. These include:

- Sustainable development, including environmental technologies and research, clean technologies, renewable energy, sustainable climate mitigation/renewable energy
- Health, including medicine
- Biotechnology
- ICT
- Nanotechnology

It should be noted that the Member States that do not explicitly adopt thematic orientations in their strategies in fact have similar foci at the level of instruments and areas of actual cooperation.

3.2 Lessons for monitoring

Taking up indicators that focus on policy-making process and strategy formulation should be interpreted carefully. It should be stressed that, for a number of reasons, the existence of strategies and their implementation does not convey much information on their impact on actual cooperation activities. First of all, a well-written elaborated strategy does not automatically lead to the implementation of policies – in order to determine the real impacts of STI cooperation one should measure activities or, rather, 'follow the money', to filter out the highest (potentially rhetorical) priorities of policy makers. Secondly, in a small number of countries there is a bottom-up approach towards STI cooperation – which implies that councils, agencies, universities and PROs, or even individual researchers may decide on the modes of STI cooperation. When embedded in a guiding framework this may lead to outcomes similar to where there is a strong strategic priority setting. Thirdly, some strategic directions may be perceived as obvious and thus do not need strategic policy support. This may, for instance, be the case with cooperation with the leading STI research nations.

While the existence of overarching policy strategies and the content of these strategies may not be indicative of the activity or intensity of international cooperation, it is however an indicator of the importance of STI cooperation at policy level, and it may serve as a proxy-indicator of existing coordination and control on monitoring and evaluation. It went beyond the scope of this study to measure the effectiveness of the strategies in the countries, moreover these strategies have not been in place long enough to measure impacts. It is thus impossible to tell whether a dedicated and standalone strategy leads to improved policymaking and therefore brings along more impacts. It is however observed that strategies have a coordinative function and if implemented successfully they will realise alignment between the different actors involved. Such coordination mechanisms may be pivotal to complementary policies and actions by the wide range of actors involved. Also, more elaborate types of strategies and policies provide stronger entrance points for evaluation and monitoring of evaluation as the logic of output, outcomes and impact can be linked to specific goals.

Similarly, it may be concluded that explicit priority setting with regard to geographic or thematic hot spots do not tell much about the impacts of realising these priorities. Nevertheless, monitoring and evaluation of these priorities do give insights in trends in internationalisation of STI cooperation: this study confirmed the expected rise of BRIC

countries as a priority and also showed that a small number of countries are looking for ‘next generation’ BRICs.

4. Policy implementation

This chapter provides an overview of policy implementation in terms of policy measures and instruments. First, an overall picture of the types of measures and instruments that are in place in many of the Member States is offered[14]. Second, the main findings from the country reports are presented. Third, it draws lessons for future monitoring requirements.

4.1 Policy measures and instruments to stimulate international S&T cooperation

The preliminary screening of the EU 27 shows that, within Europe, a range of policies and instruments is in place in the Member States – often with a different rationale. In many cases, these instruments are primarily focused on activities within the EU, while they remain open for extra-EU co-operation. The next section will further elaborate on the instruments that specifically focus on third country collaboration, but first a full list of existing relevant measures and instruments is provided:

- ***Bilateral agreements and MoUs.*** Agreements and MoUs are mostly made at the level of ministries, agencies or universities. In general, these agreements provide a framework for cooperation and many of the modalities of instruments detailed in this list (such as mobility schemes for instance) may be embedded in the agreements. Having a range of agreements does not necessarily tell anything about the intensity of international cooperation. In fact, in some cases, Country Correspondents report that it remains unclear whether an agreement is actually used for STI cooperation. Some agreements have been used, but seem currently inactive. The uncertainty of the level and scope of activity within such agreements makes it rather unreliable to simply measure the number of agreements and/or MoUs.

- ***Multilateral agreements and programmes.*** These include agreements and programmes that are mostly made at the ministerial level and which are often the basis for the formation of networks between a number of countries. These arrangements may include cooperation in the field of research infrastructures or multilateral or inter-governmental organisations such as the United Nations or the organisation of Ibero-American States, NordForsk and also those EU INCO–NETs open for third country participation, and ERAnets.

- ***Mobility schemes open for extra-EU participants.*** This type of measure is aimed at promoting either inward or outbound mobility of (groups of) researchers, for short and/or long term assignments, visits, etc. It is a very common and omnipresent

[14] This information is based on the preliminary screening of the EU-27 countries during the inception phase of this study.

instrument used for many different motives, such as mutual learning, capacity building and for attracting, retaining or developing human resources for S&T.

- ***Partnership programmes and initiatives.*** Joint R&D projects and partnership programmes are often framed in bi- and multilateral agreements. These programmes and initiatives range from joint commissions and expert groups, to programmes to improve the quality of research or research centres in developing countries, partnerships between research agencies, funding programmes (including calls for proposals and grants for researchers) and promotion programmes. They may also include programmes to support the joint development and use of research infrastructures and programmes to organise seminars and exchange knowledge and experiences amongst researchers. They might be focused on a particular domain (health, environment) or a specific target group (PhDs, PostDocs, etc).

- ***Foreign branches or subsidiaries***. A number of countries, agencies and institutions have foreign branches, subsidiaries or technological attachés in third countries. Foreign branches are a gateway for technology transfer and often have a primary function in increasing national competitiveness, exchanging knowledge, and building S&T capacities. Mostly these branches are limited in size, with an expert with local knowledge and networks.

4.2 Main findings from the country reports

4.2.1 Opening up to third countries

Although many of the instruments and activities are primarily focused on cooperation with other EU member states, a number of instruments are specifically geared towards stimulating S&T cooperation with third countries, mostly the BRICs, the United States, and countries that are historically tied to the particular Member State, or in which the Member State has a particular cultural or political interest. Sweden, for instance, takes a strong bottom-up approach and, as a result, has a very large set of initiatives and instruments in place and a specific agency (SIDA) which pays significant attention to international STI collaboration, mainly focused on capacity building. The UK also has a broad range of funding mechanisms in place, from country specific to bottom-up responsive mode approaches. These generally involve facilitative schemes for mobility, travel and short stays, but large scale research support may also be offered (especially via general Research Council support).

Austria, Finland and France specifically report that many of the activities and support mechanisms in place for (third country) STI collaboration focus on the institutional level and assist PRO and HEI actors, often in developing countries to strengthen the S&T system in that particular country.

In a number of countries (Austria, Germany, France, Finland, the Netherlands) RTD programmes are open for the participation of researchers from abroad and no real distinction for researchers from different countries is made. In many of these cases, however, it is not allowed to spend funding abroad without co-funding from the partner

country, except maybe for particular cases in the developing world. An example of such 'opening up' is the Finland Distinguished Professor Programme (FiDiPro), which aims at bringing distinguished researchers to work with Finnish researchers and academics. In June 2012, out of 104 FiDiPro researchers listed, 64 were from third countries, although some were repatriating Finnish researchers who had worked for a period in a third country. Also, the A. Von Humboldt Foundation (Germany) devotes more than half of its fellowships and awards to researchers outside Europe. However, quite a number of the selected Member States did not report on the opening up of existing programmes.

4.2.2 Bilateral agreements and MoUs

Many countries mention bilateral agreements with third countries, but often it is not specified what these agreements comprise, for what period they exist and how much funding (if any) is involved. They are often held at national level by the specific ministries, but also exist at the level of the funds, agencies and institutions. Below an overview is given of the main bilateral agreements that were mentioned by the country correspondents:

Austria has bilateral agreements with: the USA, Canada, China, Israel, Russia, India; for strategy development with Brazil, Mexico and South Africa; and for know-how transfer to Pakistan, Vietnam, and Thailand. The Austrian Science Fund (FWF) has a number of bilateral agreements with third countries (e.g. China, India, Korea, and Russia). BMWF and BMEIA run bilateral intergovernmental S&T agreements with: Albania (in preparation), Argentina, China, India, Indonesia, Korea, Croatia, Macedonia, Montenegro, the Russian Federation, Serbia, the Ukraine and Vietnam (plus a non-active agreement with Israel). BMVIT has put in place cooperation agreements with a large number of third countries related to infrastructure technology.

Denmark has initiated a whole range of new initiatives to provide for increased cooperation with large research nations such as the USA and Japan. These are also agreements with specific research centres of universities in the US, for instance. The Danish Ministry of Science, Innovation and Higher Education has bilateral S&T agreements on cooperation (Memoranda of Understanding) with the USA, China, India, Brazil, Israel and Japan, and expected to sign an agreement with the Republic of Korea in May 2012. These are meant to facilitate and spur the contact between researchers and high-tech companies of the two involved countries. In these agreements, researchers are exchanged and researchers participate in workshops and match-making events. The bilateral agreements are mainly supported by the "International Network Programme" which distributes funds to researchers in Denmark for networking activities with colleagues from the countries mentioned above.

Through the Academy of **Finland** bilateral programmes exist with: Brazil, Chile, Canada, China, India, Japan, Russia, South Africa and the USA.

In **France**, ANR has 67 Hubert Curien Partnerships or Bilaterals with Brazil, Colombia, Mexico, Venezuela, Argentine, Chile, Uruguay, Indo-French states; the Frontiers of Science Programme (USA, Japan, Taiwan); and the Frontiers of Engineering programme with Japan. OSEO has agreements with Brazil, China, the USA, India, Morocco, Russia, Tunisia for their Transnational Technology Partnership programmes and for Joint RD&I.

BMBF in **Germany** has many cooperation agreements in place, mainly through WTZ. The German Research Foundation also has in place bilateral cooperation agreements

with partner organisations to overcome administrative barriers to research cooperation. They facilitate administrative procedures for obtaining funding for international research projects. However, these agreements are often non-committal.

In **Italy**, the most important type of agreement is the Agreement for Scientific and Technological Cooperation (annual or multi-annual duration). Here as well agreements exist on different levels; the ministries, public research entities and on the HEI level. In 2010, there were 66 agreements with third countries with scientific and/or technological relevance. The largest number involved countries in Asia (25) followed by the Americas (16). These agreements co-fund bilateral research projects of significance and researcher mobility.

In the **Netherlands**, there are a number of bilateral instruments with Indonesia (e.g. BECIN, API, SPIN), China (CAS-KNAW PhD programme, CEP, TTChina, etc.) and a number of instruments dedicated to Korea, Japan, US, Hong Kong, Brazil, South Korea, and Taiwan.

Portugal has put a large focus on its programme 'Partnerships for the future' (with the USA) and bilateral protocols of cooperation have been signed in the past with a number of other countries, particularly in Eastern Europe, Latin America and in the Mediterranean region. However, a relatively low implementation level characterizes most of these.

There is little information on the third country cooperation activities of **Spain**. Some bilateral programmes are in place, based on agreements between Spain and a third country (Canada, China, South Korea, India and Japan, and negotiations with Brazil have started).

Slovenia (SRA) issued 17 calls for bilateral cooperation in 2011. These focus on the promotion of mobility only and grants cover only the travel and subsistence costs of research projects which have obtained other national/international funding. Support is limited to establishing contacts or for supporting travel.

Sweden takes a clear bottom-up approach and according to the inventory there are no bilateral agreements, except for the Nordic cooperation. However, bilateral programmes exist, such as the Swedish Foundation for InCo (STINT) that provides funding for Strategic collaborations. SIDA carries out development projects in eight countries, and other programmes include the "Multidisciplinary BIO". Vinnova runs several bilateral programmes and cooperation agreements with China, (Sino-Swedish cooperative programme on mobile communication, and one on advanced materials); on Biotech with India, Japan, Canada and with Brazil, South Africa and Israel on various topics.

Finally, in the **UK** a large number of bilateral agreements exist, but often not including research costs.

The following table summarises the information was gathered on bilateral agreements and MoUs with third countries. However, counting the number of agreements should be done with care since it does not provide information on the actual content and scope of the agreement and thus will not provide information on the intensity or level of the cooperation.

Figure 5 Summary of bilateral agreements and MoUs (non-exhaustive)

Country	Ministry/Agency: Partner country
Austria	**Government:** USA, Canada, China, Israel, Russia, India, Brazil, Mexico, South Africa, Pakistan, Vietnam, and Thailand. **FWF:** China, India, Korea, and Russia. **BMWF and BMEIA:** Albania, Argentina, China, India, Indonesia, Korea, Croatia, Macedonia, Montenegro, the Russian Federation, Serbia, the Ukraine, Vietnam and Israel(non-active agreement). **BMVIT**: a large number of third countries
Denmark	**FIVU:** USA, China, India, Brazil, Israel and Japan and the Republic of Korea.
Finland	**Academy of Finland**: Brazil, Chile, Canada, China, India, Japan, Russia, South Africa and the USA.
France	**ANR:** Brazil, Colombia, Mexico, Venezuela, Argentine, Chile, Uruguay, Indo-French states, USA, Japan and Taiwan. **OSEO:** Brazil, China, the USA, India, Morocco, Russia and Tunisia.
Germany	**BMBF:** Many cooperation agreements, mainly through WTZ. **The German Research Foundation:** also bilateral cooperation agreements with partner organisations
Italy	**Ministries, public research entities and HEI**: 66 agreements total, of which Asia (25) and the Americas (16).
Netherlands	**Ministries, Research foundations and HEI:** Indonesia, China, Korea, Japan, US, Hong Kong, Brazil, South Korea, and Taiwan.
Portugal	USA Eastern Europe, Latin America and in the Mediterranean region.
Spain	There is little information on the third country cooperation activities of. Canada, China, South Korea, India and Japan, (Brazil).
Slovenia	**SRA:** issued 17 calls for bilateral cooperation in 2011
Sweden	**Vinnova:** China, India, Japan, Canada, Brazil, South Africa and Israel
UK	many bilateral agreements in place

4.2.3 Multilateral agreements and programmes

In most of the country reports, multilateral agreements or programmes are not specifically mentioned. However, for some of them participation in international organisations such as OECD, G8/G20 and UNESCO is an important part of the multilateral STI cooperation with third countries, such as is the case in Germany, Italy (on bio-energy) and Portugal for instance.

Germany specifically undertakes significant multilateral projects involving a range of countries. Multilateral projects are considered especially important in the area of climate change mitigation – a topic addressed by the internationalisation strategy. BMBF's CLIENT project, for instance, involves the BRIC countries as well as South Africa and Vietnam in order to work together on environmental technologies and services.

Other examples given are the Nordic cooperation programme in which Denmark participates, and in which third countries can participate as co-funders; and the participation of the Spanish Agency of Cooperation and Development (AECID) that participates in the Ibero-American Programme CYTED.

4.2.4 Mobility schemes

Most countries have some sort of instrument in place to stimulate the mobility of researchers, networking between national and foreign researchers and innovation organisations. These instruments however differ greatly from each other, but this is not always clear from the general description of the instrument. So for monitoring purposes it should be well-defined what type of mobility the instrument is actually aiming for in order to map and link the instruments with the policy goals and targets, expenditures, outputs and impacts.

Sometimes, the instrument aims to incentivise travel to a third country, sometimes it aims to attract researchers from those countries to the Member State. They may fund short visits or attendance at networking and conference events or longer stays, such as joint projects in which researchers have to visit each other or carry out a part of their research in the partner country. Most general mobility schemes might be open for third countries, and some specifically target researchers in third countries such as the developing and emerging countries in Africa, Asia and Latin America. Mobility schemes are often integrated in larger partnership programmes and initiatives that facilitate, amongst other activities, the exchange of people within the projects, for instance.

For a selected number of countries some examples are given below:

Austria has several mobility schemes in place such as the Lise-Meitner programme that aims to improve the know-how of the scientific community in Austria; the Erwin Schrödinger Fellowship that funds PostDocs to gain international experience; and the translational brainpower programme that taps and utilises the knowledge of foreign researchers in research projects. Finally, it is also involved in the ASEA-Uninet that supports knowledge exchange between partner universities in Europe and South-East Asia by exchanging scientists and postgraduates.

In **Germany** an 'Academic Exchange Service' exists, stimulating researchers to go abroad for a period. Several Fellowships are granted by the Alexander von Humboldt Foundation to fund exchanges.

Italy mentions the NIH-Regione Lombardia research Career Transition Award Programme, allowing researchers and doctors to participate in study visits, and training in the NIH facilities in the US.

The Netherlands participates in the 1000 PhD programme with China, aiming at increasing the number of highly educated (PhD) personnel in the Netherlands. Because of its large scientific potential, China had been selected for the pilot programme, Talent & Training China-Netherlands. An agreement (MoU) was signed between NWO, KNAW

and the CSC. The Dutch Ministry of Education, Culture and Science (OCW) allocated money for the set-up and selection procedure of the programme, while the CSC funded scholarships for a certain number of PhD candidates via the overseas PhD scholarship programme. The Netherlands also reported on the increasing opening-up of existing schemes of the science foundation NWO to attract foreign researchers to the Netherlands.

Portugal reported the active stimulation of mobility with the Ibero-American countries through the IBEROEKA programme, which is part of the CYTED programme in which extensive technological development and research projects are carried out by a consortium of various Latin American members. Their objective is to obtain or improve a product, process or service that contributes directly to the development of the Latin America region.

Slovenia issued 17 calls in 2011 to fund bilateral cooperation, focusing on the promotion of mobility (covering travel and subsistence of researchers).

In **Sweden**, SSF runs a strategic mobility programme, but no information was given on the particular attention to third countries. VINNOVA runs the Japan scholarships to support international exchanges with Japan. In addition, the Advanced International Training programme with SIDA and VINNOVA aims to promote innovation-led sustainable growth by funding inward mobility and training.

The **UK** reported the most extensive list of mobility schemes: The Dorothy Hodgkin Postgraduate Award scheme funded in partnership with the Research Councils and industry to support students from the BRICS and developing world to undertake PhDs in the UK; The Royal Society's Newton International Fellowship aims to attract early stage post doctoral researchers to UK research institutions; the Royal Academy of Engineering also runs the Newton International Fellowship scheme and a research exchange with China and India; the British Wellcome trust provides MIT postdoctoral fellowships; and many other travel and research awards from the charities are reported, but these are not specifically restricted to mobility between the UK and third countries. The Research Councils also fund researcher mobility such as the UK-Japanese short-term fellowship programme; the British Council's UKIERI programme with India (both mobility and skills development projects); and the UK-US joint partnership fund to support HEI projects, joint course development and student exchanges. Furthermore, an interesting example of short stay mobility schemes aiming at competitiveness rather than research is the UKTI short term business attachment scheme which offers companies the opportunity to second business experts to UKTI overseas commercial posts to develop a network or new market.

4.2.5 Partnership programmes and initiatives

Partnership programmes and initiatives can be joint committees or expert groups; funded or non-funded programmes to encourage joint activities or attract researchers and business to a country; programmes to improve the quality of RTDI systems in third countries; to strengthen the dialogue between countries; and to transfer knowledge in the broadest sense. Often these partnership programmes are developed as part of a wider S&T agreement that exists between countries, but it can also be an initiative taken by an agency or institution in a country to solve a particular problem or target a specific policy goal. This distinguishes these programmes from the other modalities: the objectives and targets of the programmes are very clear, as well as is the target group. The support in the

programme can consist of research grants, mobility funding, supporting networking events and seminars. Of specific interest are the numerous programmes of research councils to stimulate cooperation with other research councils in third countries, either to exchange knowledge or to build capacity in those third countries and strengthen the S&T system.

A number of examples are provided below:

In **Austria**, a number of joint programmes exist to stimulate competitiveness and innovation, such as the Joint economic Commissions, Expert Committees and Working Groups that aim to prepare for the access to foreign markets; the Go-International programme to encourage companies to do business abroad; and the FFG Competence Headquarters programme to attract international R&D companies or units to Austria. There is also the Joint BMVIT and BMWFJ 'COIN programme' to improve innovation performance focused on foreign companies who want to work with Austrian partners on R&D and networking projects. Also mentioned is the Appear programme – to improve the quality of teaching and research, management and strengthen scientific dialogue. Its main focus is on poverty reduction, research for development, water supply and sanitation.

In **Denmark**, The Ministry of Science, Innovation and Higher Education initiated partnerships with the H-Star centre in Stanford; UC Berkely; and the Japan Science and Technology Agency. It also established a Sino-Danish centre for education and research in Beijing for joint research projects. Furthermore, the Danida Business Partnerships exist to support sustainable development and contribute to poverty reduction by transferring knowledge and technology from Danish to local partners by establishing partnerships.

Germany runs some programmes to promote the country as a location for higher education, research and innovation such as the 'Germany – Land of Ideas campaign'. BMBF also established an online information portal reporting on strategic developments from industrial and emerging economies. Furthermore, the 'Year of science and technology' was organised (and promoted in the overseas offices). DFG also runs a funding programme to stimulate long-term cooperation through funding trips and bilateral workshops, which is increasingly used by third countries.

CDTI in **Spain** runs the 'internacionaliza programme' with multilateral and bilateral cooperation projects with various countries. There is also a sub-programme within the National Internationalisation Programme to foster Spanish participation in infrastructures and promote the internationalisation of Spanish facilities. The CSIC Spanish Research Council I-Link programme aims to establish collaboration with other research councils (travel, accommodation, meetings).

In **France**, CNRS runs the International Associated Laboratory aimed at structuring collaboration between two research teams with the aim of joint publications. It also has a programme for scientific cooperation (PICS), and initiated the CNRS international Research network to bring together French and foreign laboratories through a partnership based on a scientific project. Funding covers mobility, information exchange, seminars and workshops. The Initiative Entreprises Innovantes by the MAEE promotes partnerships between French SMEs and their counterparts in other countries offering technological and commercial opportunities. The ministry of Economy, Industry and

Employment (MINEFE) and the Agency for international business development have dedicated programmes to support French SMEs and industry to find partners abroad. Also OSEO runs Transnational Technology Partnership financing programmes, Networked Research programmes (P2R) cooperation on scientific priority areas and the creation of themed research networks. Furthermore, the 'Frontiers of science programme' organises seminars for young researchers to initiate interdisciplinary discussions on designated scientific themes, to identify new avenues of bilateral scientific cooperation. The country report also mentions the opening up of ANR national programmes by operating non-thematic calls involving foreign research agencies from third countries.

Italy has the DAVINCI system in place, an Internet database of Italian researchers working abroad in universities, laboratories or international organisations. On the regional level, the Emilia Romagna Region runs the BRICST programme (Brazil, Russia, India, China, South Africa, Turkey) to promote the internationalisation of businesses in BRICST countries.

Portugal's Partnership for the Future Programme stimulates collaboration with US universities.

SIDA in **Sweden** has allocated a budget to Swedish research for the development of capacity in poor countries. This should assist in solving development problems, and support the capacity building of the research system (programme for development research; research links programme; international collaborative Grants; research training programme'). Furthermore, a joint Brazilian-Swedish research collaboration is funded by STINT.

4.2.6 Foreign branches or subsidiaries

The most common form of foreign branches or subsidiaries for the Member States seems to be the existence of S&T liaison offices linked to the embassies in third countries that support S&T networking, knowledge exchange, and business development. In some Member States, the funding agencies and HEI institutions have their own 'subsidiaries' in place to support matchmaking, joint projects and other cooperation with the third countries.

Austria, Denmark, Germany, Italy, the Netherlands, Sweden and the UK all report the presence of S&T attachés, or overseas liaison offices in third countries, mostly focused on the BRICS, the USA and Japan.

Also, the **German** Max Planck and Fraunhofer operate centres and institutes abroad that support matchmaking between German and foreign researchers and research groups. DFG has foreign offices in China, the USA, Russia, India and Japan and Latin America to fund cooperation between German researchers and researchers in the respective country as well as to strengthen the collaboration between the funding agencies.

In **Finland**, Tekes has built up a global partnerships network of leading universities and other innovation partners around the world and promotes internationalisation as part of the FinNode network of Innovation Centres. FinNodes were established in global hotspots of economic development and R&D, to promote the internationalisation of Finnish companies, attract foreign companies and investors to Finland and strengthen

knowledge flows to and from abroad. Currently there are five Finnish Innovation Centres abroad.

The **UK** Research Councils fund overseas offices, promoting UK science and innovation, while the RCUK, the umbrella organisation for the UK Research Councils, for instance has overseas staff present in the US, China, and India. In addition, the Department for Business, Innovation and Skills (BIS) and the Foreign and Commonwealth Office (FCO) jointly run the Science and Innovation Network (SIN). This consists of around 90 staff, based in British Embassies, High Commissions and Consulates, across 25 countries worldwide. SIN officers engage with the local science and innovation community in support of UK policy overseas.

4.3 Lessons for monitoring

While reviewing the country reports, it became clear that the Member States all have a large number of instruments and actions in place to support S&T cooperation, some even specifically targeting third countries, which are shown in Figure 6.

This overview shows that all countries report on different types of partnership programmes, and almost all report mobility programmes open to extra-EU countries. Except for Portugal, Slovenia and Spain, all report foreign branches or subsidiaries in third countries. The main differences between the countries can be found in the extent to which they report on the existence of (strategic) bi- and multilateral agreements with key third countries.

Overall, not much has been reported on multilateral programmes. This does not necessarily imply that they are non-existent, but apparently are not easy to monitor.

Figure 6 Overview of the instruments in place in the EU-12 countries

Country		AT	DK	FI	FR	DE	IT	NL	PT	SI	ES	SE	UK
Typology Instruments													
Bilateral agreements and MoUs	Strategic bilateral partnerships with key third countries with budget	Yes	Yes		Yes	Yes	Yes	Yes	Yes				Yes
	Bilateral partnerships with a range of third countries			Yes						Yes	Yes	Yes	
	Low level of agreements and target third countries, seemingly no vibrant bilateral partnerships												
	None of the above												
	No information provided												
Multilateral agreements and programmes	Strategic multilateral partnerships with key third countries and significant budgets					Yes	Yes						
	Multilateral partnerships with a range of third countries		Yes		Yes				Yes		Yes		
	Low level of agreements and target third countries, seemingly no vibrant multilateral partnerships												
	None of the above												
	No information provided	Yes		Yes				Yes		Yes		Yes	Yes
Mobility schemes, open for extra-EU participants	General mobility schemes open to extra-EU	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	No General mobility schemes open to extra-EU												
	No information provided		Yes										
Partnership programmes and initiatives	Partnership programmes with extra-EU	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	No partnership programmes with extra-EU												
	No information provided												
Foreign branches or subsidiaries	Foreign branches or other subsidiaries	Yes	Yes	Yes	Yes	Yes	Yes	Yes				Yes	Yes
	No foreign branches or other subsidiaries								Yes	Yes	Yes		

Source: country reports

When monitoring these activities in the future again however, ideally knowledge would be gathered on:

- The types of measures and instruments (according to the typology provided) that are implemented in the countries, preferably including information on the policy priorities (organised as proposed earlier); targeted fields or domains, target group and countries, size and mode of funding, and duration.
- The way these instruments link to the policy goals and targets set by the national governments, agencies and HEI institutions.

The country studies provide an overview of the existing policy programmes and instruments that exist in the Member States, but more information on the specific features of these instruments is still lacking. This requires a substantive investment by the country correspondents to further describe and map the existing policy measures.

A challenge for monitoring the types of instruments furthermore will be to further specify the proposed typology: most instruments include several modalities, target more than one policy goal or target group, and so forth. Based on the objectives of the monitoring (which has to be decided by the countries and the European Commission itself) policy measures and instruments can be grouped either (a) according to their modalities (mobility schemes, MoUs, S&T agreements, etc.) or (b) according to their policy goals and targets that have been set at different levels by governments, agencies and HEI institutions. For each, a combination can be made to get a better picture of the differences in instruments and policy goals. An example will be provided in Appendix B. When monitoring the instruments, the major question would thus be 'what type of instruments are in place' and 'What policy objectives and targets do they have?'. This would enable a better linking of strategies, measures, and eventually outcomes and impacts in a logical order and provide useful information for future learning and optimisation of policies and policy implementation. Clearly, a detailed typology and monitoring proposal can only be made when it is very clear what question – or objective – should be answered by the monitoring exercise. The specific design of the monitoring system would depend on the policy objectives to be monitored.

When organising the information from the country reports according to both the broad objectives of the instruments as proposed in the first chapter of this report (achieving research excellence; attracting/retaining/developing human resources for science and technology; competitiveness and innovation; science diplomacy; S&T capacity building; tackling grand challenges) and the types of instruments (bilateral agreements and MoUs; multilateral agreements; mobility schemes; partnership programmes and initiatives; foreign branches and subsidiaries) an interesting overview of the policy mix can be provided for each of the countries.

Figure 7 Policy priorities of the instruments implemented

Policy priorities	Achieving research excellence	Attracting/ Retaining/ Developing HR for S&T	Competitiveness and innovation	Science diplomacy	S&T capacity building	Tackling grand challenges
Instruments reported to tackle this specific priority / reported examples	AT, FR, SE	AT,DE,DK, FIFR,IT,NL PT SE,UK	AT,DK,ES,FIFR,IT,NL, SE,UK	AT,DE,DK, FR,IT,NL,UK	AT,DE,DK, ES, FI, FR,IT,NL PT, SI, SE,UK	AT, DE, DK,ES, FR,NL,UK
No instruments reported to tackle this specific priority/ no reported examples	DE, DK, ES,FI,IT,NL PT,SI, UK	ES, SI	DE, PT, SI	ES,FI,PT,SI ,SE	-	FI, IT,PT, SI

Source: country reports

First of all, this shows that most of the most instruments and examples reported by the country correspondents do not explicitly aim at achieving research excellence as such - it is included in many of the other objectives, but is, interestingly, not mentioned as a primary driver. It is often part of the policy objective to build S&T capacity in a broader sense, and producing joint publications is not an explicit goal for these activities. An explanation might be that the notion of supporting excellent research and boosting national research excellence has become invisible since it is a mainstay for research support and is hidden by a range of additional objectives.

Second, attracting, retaining and developing HR for S&T is usually supported by inward mobility schemes, promotional (partnership) programmes to attract researchers to the country; opening up of fellowship and other grant programmes; and bilateral agreements in general. When monitoring these measures, a distinction should be made between the S&T capacity building in general (a mix of infrastructures, knowledge building and HR development), between HR development alone and the (inbound) HR development through the attraction of qualified researchers. Further, another type of measure can be distinguished, namely those focused on 'brain churn' (as opposed to 'brain gain') to have researchers flowing both outwards and inwards.

Third, the instruments linking to competitiveness and innovation are mostly about business relations and attracting R&D to the EU country, through bi- or multilateral agreements, foreign branches or partnership programmes. Many of these instruments also closely link to the science diplomacy policy goal and the innovation centres and foreign subsidiaries to strengthen the networks and promote partnerships and internationalisation, both in research as well in (SME) business.

Fourth, it is much more difficult to monitor activities that support science diplomacy. The most obvious format are the science and innovation attachés who are actively promoting competitiveness and innovation, the attraction of S&T HR and who foster FDI and trade

interests. Other S&T diplomacy activities might exist, but are not easily monitored since budgets are often not specifically targeted to these types of activities.

Most S&T bi- and multilateral agreements and partnership programmes and foreign branches aim to build S&T capacity for the countries involved. It is however challenging to specify what 'building capacity' exactly means, and when this is successful. These activities mainly focus on supporting the development of joint projects and programmes, communication activities in third countries, etc.

Finally, tackling grand challenges is mostly mentioned when the national Ministry of Foreign Affairs or the development agencies play a leading role. These may then include partnerships on climate change or specific multilateral or bilateral agreements to foster health, development, etc. in developing countries or to strengthen the research system in these countries. Although few activities that specifically aim for tackling grand challenges have been mentioned in the country reports, the project team suspects that in practice many grand challenges form the basis of much unseen collaborative activity, particularly in climate change mitigation topics, and health, but also in areas such as flood defence, disease control, etc. Hence, the cooperation programmes identified in this area probably represent the tip of the iceberg of the associated cooperation that takes place.

5. Financial data on INCO

One of the objectives of this study is to make a review of international STI cooperation expenditure by EU Member States. These expenditures would ideally represent a good proxy for the weight of the STI-cooperation activity within a country, for the trends over time and would allow a comparison between countries. This chapter discusses the issues related to providing expenditure data for STI-cooperation with third countries and presents the findings of the country study results on this matter. In order to create a good understanding how expenditure data can be used, the next paragraph elaborates on how the expenditure data should be interpreted. Section 5.2 subsequently describes the country data for the twelve countries under review. The last section discusses what steps are needed for future monitoring and evaluation on the basis of expenditure data.

5.1 Understanding expenditure data on STI-cooperation

Ideally a complete overview of expenditures would provide:

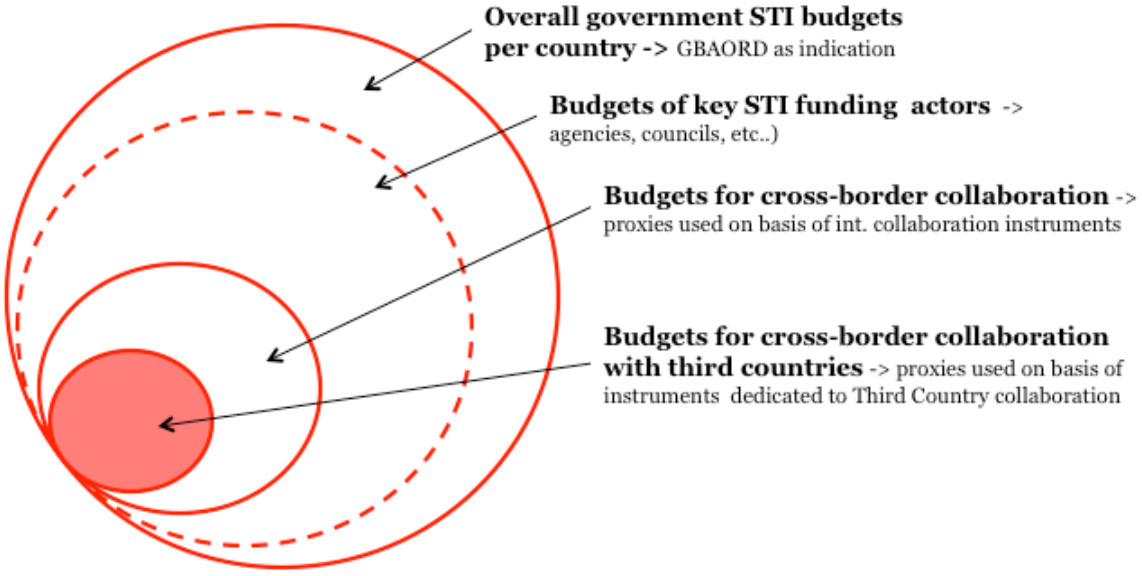
- The total annual public expenditures for STI cooperation of each European Member State with third countries for a number of years, going back until 2000 in order to analyse the trend in expenditures over time and the compare the absolute size of this expenditure
- The total annual public expenditures for STI cooperation of each European Member State with third countries in relation to the overall public STI expenditures for STI in order to ascertain the relative weight of STI cooperation with third countries in their policy portfolio

The double counting of expenditures also needs to be avoided: funding appearing on, for instance, a ministry's budget could be implemented through an agency or other research funding body or directly by the research and innovation performers themselves. The identification needs to include a number of concentric circles to finally highlight the specific funding used for STI cooperation with third countries. The following figure shows the different layers involved. There are various indicators for the total government spending on STI-budgets (GBAORD) in a particular country. Thus if the total expenditures for STI-cooperation with third countries would be available, a weighting per country could be provided.

In order to identify what is dedicated specifically to international cooperation the project team would analyse the activities of the various public-funding agencies that have programmes for providing financial support to research. The most reliable information can be obtained from public programmes that are solely dedicated to STI-cooperation with third countries and which have earmarked annual budgets for those programmes.

However, a large part of the funding that is allocated directly to research performers through institutional funding is still missing. The country studies show that a large share of international cooperation activity is happening bottom up using the basic institutional funding, for instance, for universities or large PROs such as the Max Planck Institutes in Germany. It has to be noted that focusing on public expenditures delivered through programmes is only a *'tip of the international cooperation iceberg'*. Even if all agencies and research funders in the country reviews are included, it appears to be very difficult to distinguish between expenditures for international STI cooperation in general and that part specifically dedicated to third countries.

Figure 8 Different layers of expenditures



In order to use expenditure data for comparative analysis a clear definition is needed on what is considered to be (public) STI-cooperation expenditures. As was made clear in the chapter on types of cooperation measures, the following types of public expenditures exist:

- The funding of networking activities between national and foreign researchers or research and innovation organisations. This means the funding of, for instance, travel and reimbursement costs, short visits, conference attendance and so on. These expenditures are usually quite limited on a national scale.
- The funding of a facility or service that is based in a third country which provides information to national persons or organisations, such as the funding of a scientific attaché or of an innovation service centre in a particular country. The size of the funding depends on the number of third countries covered and the size of the service facility provided.
- The funding of national individuals (researchers) to perform research abroad or for international researchers to perform research in the host country. In

these mobility-type programmes, grants are usually provided to cover the living costs of a particular person and perhaps some additional funding for a wider research group. The size of the expenditure depends on the size of the programme and the number of people involved.

- The funding of a (multi-annual) research project conducted by a national organisation (e.g. university, company) in cooperation with another organisation in a third country. The expenditure thus only covers the research or innovation activities of the national organisation. This is for instance particularly the case in bi-lateral programmes where the funding is 'mirrored', i.e. where both countries cover their own researcher's costs. In this case the expenditures logged would only be that of the European counterpart.
- The (part) funding of the entire joint research project costs regardless whether it is conducted by the national or the foreign organisation from a third country and whether the research is performed domestically or in the third country. This would also include the opening up of national programmes to foreign partners who receive funding from the EU Member State. In this financial model the total expenditures for a country could become significant if the programmes are of a considerable size. A pattern can be detected where this type of financial support is often used for capability development in developing countries.
- Finally the costs of a joint investment in research infrastructures together with third countries.

Given all the types of expenditures that could be considered as national expenditures for STI-cooperation with third countries a fine granularity is needed of public expenditures to exactly establish the size of the national budgets.

In practice the project team has come across a number of bottlenecks that have prevented the review from achieving this level of granularity per country:

- An increasing trend of 'mainstreaming' STI cooperation: general programmes to fund research and innovation have an element of international cooperation but the degree and size of cooperation and the funding modality varies from project to project. Finland is an example where the main funding agencies, Tekes and the Academy of Finland, have mainstreamed funding for international cooperation in their programmes. Exact data on how much of the general funding is used for international STI cooperation is not available. In The Netherlands, programmes for certain countries have a mix of modalities which include financial and non-financial elements.
- Many dedicated initiatives for cooperation for the HEI-sector have a mix of educational and research cooperation activities. The available data mostly do not distinguish between these two. In a similar vein, international innovation programmes often have a combination of classic trade support (e.g. helping companies to find and work with trade partners) with some components of innovation in that programme. An example of the latter is the Austrian 'Go international' programme that is mostly about trade but also has some small

sub-measures specifically dedicated to high-tech cooperation. The budgets for these particular projects are not publically available.

- Even if agencies and research and innovation funders specify the budgets for international S&T cooperation, they would most often not distinguish between intra-European cooperation and cooperation with third countries. Intra-European cooperation is by far the most important geographical destination of cooperation although various Member States report a shift in favour of third countries. General STI cooperation programmes can leave it up to the users in which third country they seek a partner. Hence the budgets for these programmes show a mix of intra-European and non-European cooperation. It is an exception rather than a rule that agencies have and/or publish data that specifies the geographical destination of the funded cross-border projects.

Thus the project team has to conclude that all these bottlenecks prevent the review of reliable data for STI cooperation with third countries. While some countries have quite good data on the programme level, for none of the 12 countries under the review can it be stated that the overview is complete and reliable.

5.2 Main findings of the country reports

With the health warnings provided in the previous paragraph, the following will synthesise the findings of the 12 Member States reviewed. As the country data on the total expenditure for third country STI-cooperation are too unreliable the project team will refrain from giving a weighting in relation to all STI-expenditure. The most recently available data varies with some country reports already providing data for 2011 while the most recent data from other country reports are only for 2009 or 2010. An additional issue is how to allocate the funding for Nordic initiatives in Denmark, Finland and Sweden. While they are mostly intra-EU Member States and with Norway being an Associated country, these expenditures hardly count as cooperation with Third countries. The Nordic Country expenditures are thus not included in the table below as they distort the picture.

The following gives a short summary of the findings for each of the countries in terms of the information on expenditures that can be found in the individual country reports:

- **Austria;** The budgetary information from Austria is compiled by listing the major funding organisations and agencies involved in STI policy and specifying which initiatives, programmes and dedicated institutions involve STI cooperation with third countries. Austria has a large number of instruments of which some fund only the networking costs for bilateral mobility programmes, while others have large budgets. An issue is that Austria has large funds for cooperation with developing countries which includes activities other than just research, but no budgetary split is provided. Austria is also the only country that has opened up its national STI programmes and allows for some funding (to a maximum of 10%) to go to foreign partners. The exact amount going to third countries is unknown but the USA is a frequent partner. A relatively large programme (€39 million for 2011/2012) is Go International, which includes classic export support but also

international innovation cooperation. However, an estimate (10%) had to be made regarding the proportion dedicated to innovation and technology cooperation. Thus, in the view of the project team the overall budget for Austria is likely to be overstated.

- **Germany**; It proved difficult to obtain budget data for some of Germany's main organisations involved in international STI cooperation. The implementation of STI cooperation is done mostly through dedicated institutions, general cooperation agreements (often without funding) or service facilities. Most actual cooperation activity is done by the research actors themselves. An estimate has been made on the basis of figures on the International Bureau of BMBF. Given the number and size of other organisations involved in STI cooperation the total estimated expenditure figure is most likely heavily underestimated.
- **Denmark;** A considerable share (25%) of Denmark's STI cooperation goes to Nordic cooperation which is thus mostly internal-EU Member State. There is dedicated funding for some innovation centres and a Sino-Danish Centre for Education and Research. The largest share of the total expenditure is allocated through the Danida Business Partnerships which are not exclusively for innovation. Thus the Danish total expenditure figure is most likely overstated.
- **Finland;** International STI cooperation is mainstreamed in the regular STI programmes of the two largest agencies Tekes and Academy Finland. This is a bottom up-process and the partner is mostly sought by the research performers thus the geographical location (EU or non-EU) is unknown in the data. There are only a few dedicated programmes for STI cooperation with the bilateral programmes of the Academy of Finland being the largest with an estimated expenditure of €10 million. The total figure for Finland is likely to be in the reported range.
- **France;** Many policy domains and organisations are involved in international STI cooperation. The country report has the total expenditure figure for STI-cooperation for the Ministry of Foreign Affairs and the largest research funding agency ANR. While these will include some intra-EU and some non-research funding the total figure for France will still likely be underestimated as not all actors in the system are included in the budget overviews.
- **Italy;** the calculation of Italian expenditures have included the Significant Research projects for Third Countries, the budgets for the Ministry of Foreign Affairs, the Ministry of Education and Research, the National Research Council and some dedicated initiatives. Not included in the total estimate is the large programme for Sino-Italian environment protection as it is likely to include many non-research innovation elements. The total estimate is likely to be in the reported range.
- **The Netherlands;** the expenditure of The Netherlands is fragmented across many actors and programmes for which budgets are very small. Initiatives mix mobility and networking with joint research projects. Budget information for many of these programmes had to be estimated. Overall the budget estimation includes a wide range (between €9 and 15 million per annum). This is likely to be in the range of all STI cooperation activities with third countries.

- **Portugal;** Reasonably reliable data exist for international STI cooperation, but data are not always publically available: how much is allocated to intra-European cooperation and how much to Third countries. Portugal has one very large programme that takes up a the largest share of the budget (€166.5 million between 2007-2011) which is geared to research cooperation with three leading US universities. The size of this programme alone is larger than the total STI cooperation budget of other small countries. The total estimate of Portugal is likely to be in the reported range.
- **Slovenia;** A quite detailed estimate could be made of the Slovenian cooperation expenditures as precise budgetary information is available for a number of bilateral cooperation agreements (that mostly fund travel and networking). Slovenia is the only case where it was reported that planned budgets were not spent as research institutions claimed not to have sufficient time for foreign travel and networking.
- **Sweden;** the budget expenditure data for Sweden are based on the budget for STI cooperation of the main innovation agency VINNOVA. As Sweden mostly operates with a bottom-up approach to international cooperation, this figure is likely to underestimate the total monetary value of international STI cooperation with third countries
- **United Kingdom**; The UK has so many actors, (ministries, funding agencies, societies and so forth) from many policy domains that it has not been possible to make a reliable estimate of the expenditure for STI cooperation for third countries. As the total budget for international STI cooperation (in 2010 estimated at 1,079 million pound sterling) is one of the largest of all countries under review, it is safe to expect that the sum of this budget allocated to third countries will be the largest amount of the countries under review in this report.

The following table gives an allocation of countries in terms of the absolute expenditures in the most recent possible year. The project team has defined three groups of countries: those that spend less than €10 million on a yearly basis, those that spend between €10 and 20 million and those that spend more than €20 million.

Figure 9 Estimate of annual expenditures on international STI cooperation with third countries

Annual expenditure < €10 million	Annual expenditure between €10 - 20 million	Annual expenditure > €20 million
Slovenia, Sweden	Germany, Finland, Italy, The Netherlands,	Austria, Denmark, France, Portugal, Spain, UK

Source: country reports

5.3 Recommendations for future monitoring

As said before, a number of bottlenecks prevent the review of reliable data for STI cooperation with third countries. A good budgetary overview is lacking. To be able to

provide clear recommendations on what to monitor in the future, a clear question, or purpose for the monitoring activity, needs to be formulated.

However, a number of actions can be taken on a Member State level:

1. First, Member States can work together to collate the key data available such as the total expenditure on STI for instance (e.g. GBAORD)
2. Next, each Member State should attempt to structure the available data in order to be able to derive a picture of the share of the total STI expenditure that can be related to international STI cooperation. The responsible agencies and ministries could map this on a more regular basis in relation to the instruments used to promote international STI cooperation. A challenge will be to identify funds dedicated to international STI cooperation in the general programmes that have no specifically delineated budget for cooperation. For basic institutional funding this is likely to be impossible to map. The MS should agree on a mutual definition of (public) STI cooperation expenditure.
3. Third, a more difficult task will be to identify the share of the international STI cooperation expenditure specifically targeting cooperation with third countries.
4. To avoid double counting, clear agreement should be made about allocating these budgets to either the ministry or the agency implementing the policy for instance.

6. Trends

The previous chapters showed that it is difficult to declare that there is a trend towards more or less focus on, and funding for, international STI cooperation. Issues such as mainstreaming of international STI cooperation activities and funding into other policy measures and budgets, makes it hardly possible to monitor trends in this area. Moreover, little information was given on trends in policy objectives or instruments to implement these policies. Most country correspondents therefore did not provide much information on these topics.

The trend that was reported relates to the opening up of instruments, this seems to have increased over the past ten years and third country researchers are increasingly stimulated to participate in national funding mechanisms, grant- and fellowship programmes. Moreover, Italy reported that there is a focus on fewer thematic fields and countries; and that fewer public resources are available, especially for development assistance. Increasingly, research and innovation is recognised as inseparable from economic competitiveness by the country's policymakers. The latter was also mentioned in the Dutch country review. Overall, if budgets went down, this seems to be a part of the general budget decline due to the economic crisis since 2008.

Figure 10 displays the trend over time regarding the expenditures for international cooperation. Here the lack of historical data was a major problem in obtaining exact figures. The project team has defined three groups of countries: those where expenditures have decreased in the last (five) years, those where the pattern is stable and those that show an increase.

Figure 10 Trend of annual expenditures on international STI cooperation with third countries

Decrease of expenditures	Stable expenditures	Increase of expenditures
Italy, Portugal, Slovenia	Sweden(?), The Netherlands(?), Spain, France?	Austria, Germany, Denmark, Finland, UK

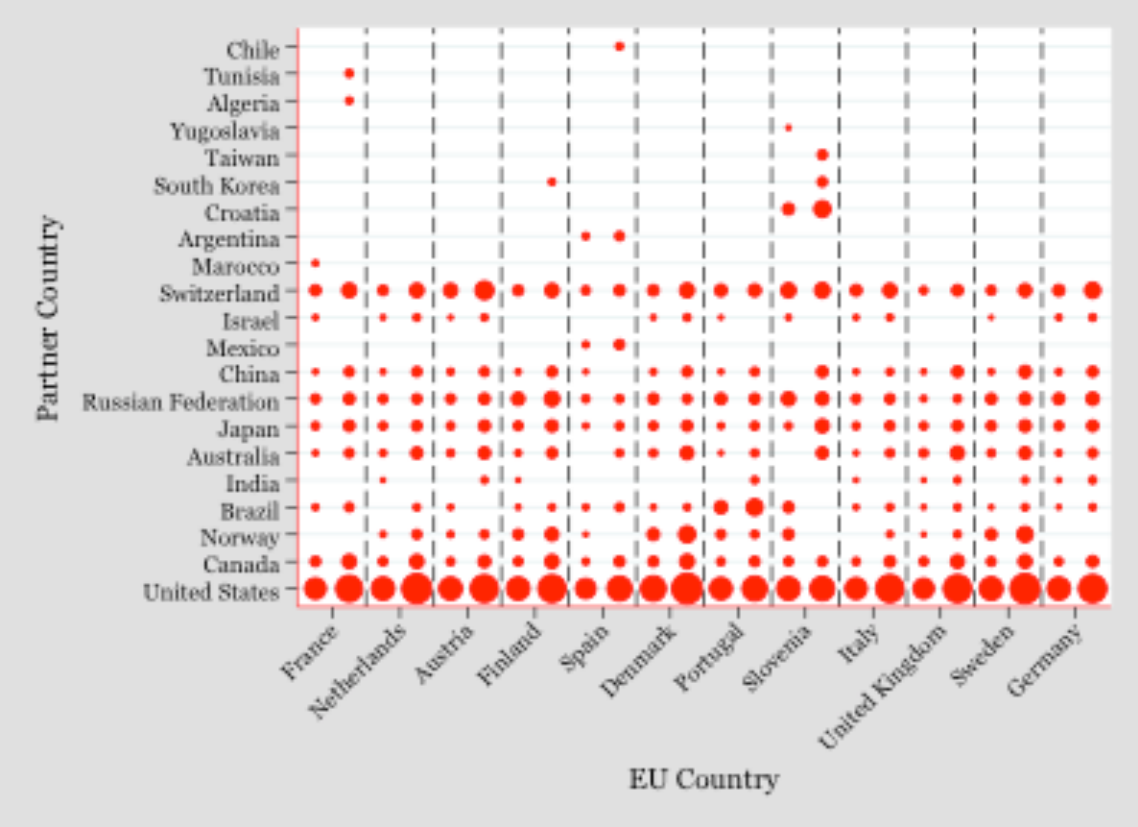
Source: country reports

Based on the country reports and secondary literature and review, there is one type of trend that can be monitored fairly easily, and that is the way the geographical focus of the Member States has changed over the past years. This can be monitored through bibliometric analyses (co-publications) as well as analysing the geographical focus of the S&T agreements and MoUs that have been signed over the years. The following paragraphs will provide an overview of the geographical focus and trends of the member states based on bibliometrics and secondary data both from the perspective of the member state as well as the third countries.

6.1 Co-publication patterns and trends

For the selected EU member states the project team has performed a quick analysis in SCOPUS to analyse patterns of co-publications with third countries, and the changes over time. For each of the 12 Member States a search was performed and the top-ten third countries that in some way participated in a publication with the EU Member State were identified. The analysis showed that the 12 Member States primarily co-published with researchers from the following countries: Australia, Brazil, Canada, China, India, Israel, Japan, Norway, United States, Russian Federation, Switzerland, both from 1991-2000 as well as from 2001-2010. This is presented in Figure 11, where the size of the sphere relates to the co-publications with the partner country as a share of the total number of publications of the MS, for each period of time.

Figure 11 Share of co-publications with partner country



Source: Scopus

French researchers also co-published relatively much with researchers in Morocco, Tunisia and Algeria. Slovenia also has in its top-ten the number of co-publications with researchers in Croatia, South Korea and Taiwan. Together with Finland, Slovenia is the only country out of the twelve with South Korea in its top-ten of third countries. Spain co-publishes, besides the previously mentioned countries, much with Argentina, Mexico and Chile. US researchers are by far the most popular to cooperate with for the twelve Member States: between 6 and 15% of the total share of publications for each of the Member States is co-published with at least one US researcher. Norway and Switzerland come second and third in many cases, which is not surprising considering their proximity and their 'involvedness' in the EU and EC.

For a number of countries (Austria, Germany, Denmark, France, Italy, the Netherlands, Slovenia, Spain and the UK) the position of the Russian Federation goes down in the top-ten when comparing the periods 1991-2000 and 2001-2010. Australia and Japan became on the other hand more popular judging from the co-publications with researchers from these countries in the years 2001-2010. Overall, for most of these third countries, the share of total number of publications in which they participate increased compared to the years 1991-2000. This could be a sign of an overall trend that researchers in the last ten years have been cooperating increasingly with researchers from abroad, including from third countries.

It is important to view cooperation patterns from both perspectives, since such observations represent a single snapshot of activity and may presage important developments with regard to future cooperation patterns and strategic policy decisions. For example, if China exhibits a disproportionately high level of scientific cooperation in, say, Clinical Medicine with the UK and yet this is not reciprocated in the proportion of UK Clinical Medicine co-publications with China, it could imply that the UK is perceived as a world leader in this area of research which has implications for strategic policy in terms of possibly facilitating increased levels of such cooperation from the UK side and developing potential industrial and related cooperation or links.

6.2 Lessons for monitoring

The use of bibliometric indicators (publications, co-publications and citations, etc.) is firmly established as a means of assessing international activity in STI. However, the evidence collected from the country reviews indicates that such data is not routinely used in the monitoring of national (or other level) policies in these activities except when employed in international benchmarking exercises, which are generally commissioned from experts in the use of bibliometric techniques. Their use as routine policy monitoring tools is therefore limited. Moreover, being concerned primarily with scientific productivity and impact, rather than activity, presence, movement, or influence, for example, they do not provide insights to the range of alternative and broader motivations that underlie the support of internationalisation activities in STI. Bibliometric indicators do, however, exhibit greater potential in the evaluation of the outcomes and impact of national programmes for STI cooperation and the activities of national funding agencies, etc. Recent examples may be found in the evaluation of the Human Frontiers Science Programme and the Research Council of Norway[15].

Moreover, the studies of Mattson, et al (2008 and 2010) and Wagner and Leydesdorff (2005) argued already that scientific cooperation (as measured by co-publication) is strongly geographically influenced with a tendency to collaborate based on geographic proximity and that it is also a bottom-up driven decision process which is less influenced by institutional or policy-related concerns. In the context of this study, the implications are that top-down policy decisions and frameworks (e.g. internationalisation strategies) are possibly likely to have less impact on research cooperation in practice than the self-interests of researchers, and monitoring on both sides might be of interest for the individual member states to understand better the effect and impacts of policies, and individual motivations for international STI cooperation.

[15] Technopolis and MIOIR, unpublished evaluation report.

7. Monitoring and evaluation of outputs and impacts

The country studies did not explicitly mention systematic evaluations or impact assessment systems of international extra-EU cooperation. However, in several countries the project team found that there are monitoring systems for the participation of national scientists in EU STI facilities, with some focus on the 'rate of return'. In addition, a number of countries have undertaken so-called 'impact studies' into national participation in the Framework Programmes (for example, the UK[16] and Sweden[17]) whilst data on application rates, success rates, level of participation (as project leader or as team member) and associated variables are also now regularly produced by the European Commission itself[18] . Such impact studies are however framed within the context of a regular and relatively standardised cooperation framework, with coordinated timeframes and operating arrangements. The absence of a comparable multinational framework for cooperation with third countries perhaps explains the lack of similar impact studies. Moreover, the (national) FP impact studies are heavily influenced by national concerns for financial *juste retour* and alignment with national research priorities rather than on an extensive analysis of the broader effects and benefits for the research base. Nevertheless, the latter concerns have been addressed by some of the evaluation methodologies employed and may provide lessons for the evaluation of third country collaboration, although at a very qualitative level: there seem to be few implications for the use of standardised metrics and indicators in this regard.

Evaluation and monitoring at programme level is most likely to take place in countries with a strong evaluation culture. In Germany the Ministry of education and research (BMBF) has internal monitoring systems in place. In the United Kingdom, monitoring is also part of the national culture of evaluation, although this operates very much at a programme level rather than at any higher level. In other countries, evaluations and monitoring are more likely to take place at programme level; retrieving this information would require deeper analysis (e.g. The Netherlands and the UK).

The aim of this section is to use the evidence from the country review to identify different types and forms of indicators which have been used to monitor and evaluate STI internationalisation activities in the selected countries, to comment on the experience of their use and to provide suggestions for potential indicators that may be developed in the future, either at the national level or under the guidance of the European Commission.

[16]Technopolis, "The impact of the EU RTD Framework Programme on the UK", 2010: available at: http://ec.europa.eu/research/evaluations/pdf/archive/fp7-evidence-base/national_impact_studies/impact_of_the_eu_rtd_framework_programme_on_the_uk.pdf.

[17] Technopolis, "Impacts of the Framework Programme in Sweden", 2008: available at: http://ec.europa.eu/research/evaluations/pdf/archive/fp6-evidence-base/national_impact_studies/sweden.pdf

[18] see: http://ec.europa.eu/research/evaluations/index_en.cfm?pg=archive#results

7.1 Main findings from the country reports

Although almost all the Member States covered in this study are known to regularly employ evaluations in determining the impact of policy implementation, the extent to which such procedures were applied in the context of an S&T cooperation programme was found to be rather more restricted.

A number of levels of evaluation and monitoring activities (specifically in the context of internationalisation) could be identified: the country level; the agency level, and the programme/instrument level. These are further explained in the following paragraphs. Figure 12 provides an overview of the evaluation and monitoring schemes for the selected Member States.

Figure 12 Summary of evaluations per MS

Country	Evaluation of	Performed by	Level
AT	Austrian Federal Ministry of Economy, Family and Youth (BMWFJ)	Evaluation studies carried out by WIFO and the Vienna University of Economics and Business	Ministry
	Austrian Research Promotion Agency (FFG)	In-house monitoring is done by FFG. A critical external evaluation was carried out by Technopolis in 2010/2011	Institutional
	Austrian Federal Ministry of Science and Research (BMWF)	An evaluation by Buzeczki in 2004. Regular activity monitoring is done by OeAD.	Ministerial
	Austrian Science Fund (FWF)	FWF ex-ante peer review of project proposals (all peers are from abroad) FWF regularly monitors the output of projects.	Project
DE	Germany's overall STI internationalisation	Fraunhofer ISI and Technopolis Group J. Edler (Ed.) (2007): "Internationalisierung der deutschen Forschungs- und Wissenschaftslandschaft" - Commissioned by BMBF	National
DK	No evaluations mentioned in CR		
ES	No evaluations mentioned in CR		
FI	No evaluations mentioned in CR		
FR	The Academic and Scientific Cooperation Programme (CORUS 1)		Programme
	COFECUB (Comité Français d'Evaluation de la Coopération Universitaire et Scientifique avec le Brésil), ECOS (Évaluation Orientation de la Coopération Scientifique) with Colombia, Mexico, Venezuela, Argentina, Chile and Uruguay		Programme
IT	International cooperation programmes	All Italian ministries employ the same type of monitoring and evaluation mechanisms to ensure transparency, evaluation and merit.	Programme
NL	The scientific quality of KNAW supported activities	The Royal Dutch Academy of Arts and Sciences (KNAW)	Institutional
	JSTP	Dialogic	Programme
PT	Activities of IICT researchers in its	The Institute for Tropical Research (IICT)	Individual

	laboratories		
SI	No evaluations mentioned in CR		
SE	SIDA Evaluation Unit	SIDA	Institutional/ programme
	VINNOVA Programmes	VINNOVA	Programme
UK	In general: all public sector funding bodies in the United Kingdom are required to undertake monitoring and evaluation procedures on their publicly supported research activities.		
	Bilateral S&T cooperation schemes	PREST -Commissioned by the British Council	Programme

Source: Country reports

7.1.1 Country level: assessment of internationalisation activity

A number of countries report that the issue of international cooperation has formed a topic of policy assessment or analysis, either as an issue in its own right (though often as part of a one-off study) or as one topic amongst a broader national analysis of STI policies and activities.

For example, an evaluation commissioned by the Finnish Ministry of Employment and the Economy in 2009 stated that there was a lack of international cooperation, and an absence of policy focus on it. An International Evaluation of the National Innovation System in 2009 found that although international cooperation has been a long time policy objective, various indicators show that Finland's performance is low compared with many other EU countries. More specifically, the Research and Innovation Council of Finland noted, "The low level of internationalisation of the innovation system is one of its particular weaknesses. In order to rectify the situation, the Council published a strategy in December 2009 on promoting the internationalisation of Finnish education, research and innovation in 2010–2015"[19]. The Policy Guidelines makes a broad statement on evaluation, noting that the intention is to evaluate all RTDI policies to assess their impact and learn from their implementation. A list of indicators is provided and those relevant to international cooperation activities are:

"Input indicators:

- Foreign students as % of all students in higher education
- Foreign-born researchers as % of total R&D personnel
- Share (%) of foreign-owned companies of total turnover of the business enterprise sector

Output indicators:

- Funding received from EU 7th R&D Framework Programme per thousand researchers
- Accepted projects in EU 7th R&D Framework Programme (number of projects / GDP)

[19] The Research and Innovation Council of Finland Research and Innovation Policy Guidelines for 2011–2015. See: http://www.tem.fi/files/30413/Research_and_Innovation_Policy_Guidelines_for_2011_2015.pdf

- International co-operation in patenting: patents with foreign co-investors (% of all)"[20]

In France, a global assessment of French development cooperation policy between 1998 and 2010 is currently under way, but there has been no assessment of French international STI Policy as yet. On a general monitoring level, the national research and higher education evaluation agency AERES, tends to use indicators such as publications and co-publications and the number of thesis co-supervisions in its studies. However, in this context, the issue of international relations strategy is integrated with the assessment of schools and educational activities, and there is no comprehensive assessment, which looks at aggregate policy across research and innovation institutions at the national level.

With the exception of the "Partnerships for the Future" initiative (an ambitious programme of cooperation with US Universities, launched in 2005 and aimed at encouraging joint programmes in specific fields in order to strengthen Portugal's STI development), there have been no overall reviews of internationalisation STI orientations, policies and trends. Similarly, no specific strategic guidelines for STI cooperation with Third Countries have been explicitly established that might require monitoring or evaluation. Although high-level policy priorities involving an increased focus on China, Cape Verde and Brazil have been framed, these decisions were apparently based on general assessments rather than on thorough reviews of policies or instruments.

Lastly, in the UK, the issue of international cooperation has formed a topic of policy concern although the main initiative has emerged from science policy advisory bodies such as the Royal Society rather than being driven by Government. Examples include the House of Commons (2007) enquiry[21] into international science and the Royal Society (2010) report[22] on scientific internationalisation. Consequently, there has been no explicit attempt to monitor or evaluate it at the general level except in the context of positioning the UK against international benchmarks. In the latter case, typical indicators include the use of bibliometric data (i.e. co-publications and citations) – for example, the Department for Business, Innovation and Skills commissioned a review of bibliometric data on the UK's performance in international activities in 2009[23], the House of Commons review looked at funding levels and the presence of international programmes, whilst the Royal Society study also made extensive use of existing bibliometric studies. The most recent study, commissioned from Thompson-Reuters by the Department for Business, Innovation and Skills, makes the case that the high level of internationalisation of the UK research system is a key factor behind the UK's continued international pre-eminence in basic research as measured by bibliometric indicators.

[20] Op.cit.
[21] House of Commons Science and Technology Committee (2007), International Policies and Activities of the Research Councils, Ninth Report of Session 2006–07, London, The Stationery Office Limited, 25 July 2007.
[22] Royal Society (2010), 'Knowledge, networks and nations: Global scientific cooperation in the 21st century'. Royal Society.
[23] Evidence Ltd: BIS (2009), International comparative performance of the UK research base, Report to the Department for Business, Innovation and Skills by Evidence Ltd, September 2009.

7.1.2 Country level: national plans and policies

As one of the few examples revealed in the review, the Spanish National Plan (2008-2011) outlines a number of indicators used to follow up the implementation of the established four-year objectives. The most relevant objective to the focus of this study aims "To boost the international scope of the Science and Technology System: coordinating policies, establishing incentives to participate in the Framework Programme, helping research staff access to international projects and networks". Of the thirteen national programmes within the Plan, the 13th relates to "Internationalising R&D". The Plan outlines the use of an "Integral Monitoring and Evaluation System (SISE)", which is described as "a tool designed for controlling the management of public funding RD&I programmes, making them more transparent and publicising the activities, to give the general public and Spanish society a better understanding of the activities being financed with public funds".

In terms of indicators, three apply to international cooperation activities:

- Quota of scientific production in respect of world total (%)
- Scientific production in international cooperation (%)
- Economic return Spanish participation in EU R&D Framework Programmes (%)

The indicator on "Scientific production in international cooperation" was reported as reaching 45% in 2011. Most of the other indicators about international cooperation specifically focus on cooperation with EU countries, notably the Spanish financial returns on participation in the EU Framework Programme for R&D.

The annual Spanish SISE Reports on the Internationalisation National Programme, report that the policy recommendations over the recent years have focused on the degree to which activities carried out have been in line with the overall policy priorities established at the National R&D&I Plan. The main findings show that the different Instrumental Strands of Action by which the Internationalisation National Programme is implemented meet the general objective of "promoting Spanish R&D groups in the International landscape and, notably, Enterprises and Public Research Organisations' participation into the European Framework Programme and big Scientific Installations". However, no specific indications are given in the report as to how this is measured.

7.1.3 Agency level

Agency level evaluations are defined as monitoring and evaluation activities undertaken by or on behalf of agencies into the performance of the entire portfolio of programmes they operate. The only specific example encountered in the country reports concerned the Austrian Federal Ministry of Science and Research (BMWF) which is known to have commissioned at least two evaluations, one by Buzeczki (2004) – a "Report on the evaluation of mobility support scientific cooperation projects under the bilateral

agreement for scientific and technological cooperation"[24] and an analysis of the potential for transferring bilateral R&D projects towards the European Framework Programme for Research and Technological Development (Schuch, Wagner and Dall 2012)[25]. However, it is also known that the UK Department for Business, Skills and Innovation is also preparing a review of the international cooperation activities carried out by UK agencies and funding bodies, particularly those with partners outside Europe.

7.1.4 Programme/instrument level

The activities under this heading refer to the evaluation and monitoring of individual programmes in support of international cooperation and related objectives.

In Austria, regular activity monitoring is done by OeAD (the Austrian agency for international mobility and cooperation in education, science and research). The Austrian Science Fund, FWF, carries out an ex-ante peer review of project proposals (all peers are from abroad) and a terminal evaluation of at least one of the peers involved in the ex-ante procedure. It also regularly monitors the output in terms of produced publications, participation at international conferences and career advancements. However, it is not clear whether this set of procedures feeds into any higher level policy formulation process.

As with many other agencies and funding bodies in the Member States, the French Ministry of Foreign and European Affairs has a long tradition of evaluation and the use of independent evaluators to review programmes. Thus international STI cooperation programmes can also fall into this general practice: an example provided is that of the "CORUS" programme of academic and scientific research cooperation (2009).

In general, these assessments usually examine indicators of programme activity rather than impact however (attendance at conferences, publications, number of stays, theses).

The CORUS programme

The Academic and Scientific Cooperation Programme (CORUS 1) is a Priority Solidarity Fund programme (FSP N°2001-22), funded by France's Ministry of Foreign and European Affairs (MAEE), which ran from 11 September 2001 to end-November 2008 with a total budget of €4 million. "As specified in the TOR, the core task was to evaluate the programme on the basis of commonly recognised criteria for public policy evaluation in addition to criteria of clarity and visibility of the programme. To summarise all these criteria and respond to the question marks about the CORUS 1 programme, the evaluation questions were designed to investigate the programme's strategy, capacity building in the partner countries, the involvement of French researchers and management of the programme."

Source: *http://cooperation.epfl.ch/page-68488-en.html*

Similarly, under a law that was passed between 2010 and 2011, all Italian ministries employ the same type of monitoring and evaluation mechanisms to ensure transparency, evaluation and merit. Thus, any relevant international cooperation programmes will fall under this requirement – however, no known examples have been cited.

[24] Buzeczki, C. (2004): Bericht über die Evaluation der Mobilitätsförderung wissenschaftlicher Kooperationsprojekte im Rahmen der bilateralen Abkommen für wissenschaftlichtechnische Zusammenarbeit. Wien: Bundesministerium für Bildung, Wissenschaft und Kultur.

[25] Schuch, K., Wagner, I and Dall, E. (2012): The potential of transfer of bilateral R&D projects towards the European Framework Programme for Research and Technological Development. In: Loudin, J. and Hochgerner, J. (2012): Social and Cultural Dimensions of Innovation in Knowledge Societies. Prague: Filosofia: pp. 169-197.

Likewise, in the Netherlands the monitoring and evaluation of international cooperation in STI with third countries does not have a high priority although there are some very limited systemic evaluations. The Ministry of Education, Culture and Science (OCW) does not evaluate its funded activities and rarely deploys any monitoring systems. Moreover, the impact of S&T cooperation is not measured. The Ministry of Economic Affairs, Agriculture and Innovation (EL&I) only monitors business related (financial) activities via the Foreign Investment Agency (NFIA) while the impacts of S&T cooperation are again not monitored. The Royal Dutch Academy of Arts and Sciences (KNAW) has an evaluation system in place, but this system is largely intended to measure the scientific quality of supported activities since this is the main aim of the KNAW - these are mainly based on publication outputs. The evaluation and monitoring activities of the Dutch Organisation for Scientific Research (NWO) are restricted to the writing of internal reports on its projects for the NWO board – indicators used are the number of projects and their outcomes, as well as qualitative feedback.

Information from Portugal was relatively sparse although it is specified that, overall, monitoring and evaluation procedures are insufficiently developed. The Institute for Tropical Research (IICT), which reports to the Ministry of Foreign Affairs carries out evaluations of the activities of its researchers in its laboratories on an individual basis by a jury process. According to the Luso-American Foundation for Development (FLAD), programme impact assessment is difficult to undertake, particularly since it depends on institutions carrying out their own evaluations of the research programmes they support. Although it was reported that qualitative impact assessment has been carried out using interviews for the purpose of investigating the long-term impact on institutional development, the report has no specific information on how this is done or what was the outcome.

Following the general trend, all public sector funding bodies in the United Kingdom are required to undertake monitoring and evaluation procedures on their publicly supported research activities. Similarly, a number of the not-for-profit bodies (such as medical charities) also undertake some form of evaluation. All these activities tend to vary in terms of depth, scope and purpose but generally involve the collection of descriptive statistics, reviews of activity reports and collection of feedback/end of project reports, etc. In addition, the evaluations may be conducted internally or may be contracted out to independent experts. By way of illustration, in 1995-1996, the British Council commissioned a team from PREST at the University of Manchester to perform a series of evaluations of a number of its bilateral S&T cooperation schemes with Canada, New Zealand and Australia. This followed on from evaluations of similar bilateral schemes with France and Germany in 1994-1995. However, although the evaluations (performed via a survey of travel grant recipients) examined outputs such as co-authored publications arising and subsequent FP grant applications, no quantitative measure of impacts or the definition of indicators was carried out.

7.1.5 No evaluation activities defined

The information provided for Germany and Finland indicated that no monitoring or evaluation procedures were in place specifically for the assessment of STI internationalisation activities. In the latter case, it was stated that no specific evaluations of international cooperation programmes have been undertaken, since few of this type of programme exist. Likewise, no information was available from Denmark while in Sweden

there is no systematic evaluation, although two agencies (presumably those with the largest budgets) do have monitoring and evaluation systems in place but do not specifically examine STI cooperation or the impacts of international cooperation.

According to the information obtained from the interviews held in Spain, there seems to be a lack of monitoring systems with regard to the follow up of international STI cooperation. However, those interviewed identified a clear need for the definition of relevant indicators, ideally during the design stage of the policy measure, prior to its implementation.

Lastly, the evidence from Slovenia indicates that no specific indicators are in place to evaluate or monitor the impact of STI internationalisation, largely since most of the funding supports mobility costs rather than research. What monitoring there is consists of the collection of individual formal reports but, due to the low size of the grants (€1,000-€5,000), monitoring is not a cost-effective management tool. No further form of evaluation has been put in place nor is it envisaged.

7.2 Lessons for monitoring and evaluation

Since many activities and programmes combine various policy drivers, often goals and envisaged outcomes and impacts are not well defined as became clear from the country studies. Moreover, effects are rarely specified or operationalised and if monitored or evaluated, this takes place at the various levels (national, agency, programme/instrument).

Currently the following broad types of measurement and indicators used at these levels can be commonly seen:

- The measurement for the scale and trends of international STI cooperation activity is often based on bibliometrics and technometrics.
- When measuring individual benefits, indicators are mostly related to mobility and science sharing.
- To measure internationalisation of technological (i.e. public/private sector) or industrial (private sector) research, one can use indicators such as for example international licensing, market share with innovation abroad, share of business R&D performed by foreign MNEs, share of patents invented abroad, number of technological alliances, etc.
- To measure the internationalisation of research institutes, one can look at the existence of strategies and plans, dedicated budgets, share of research projects done in international cooperation, etc.
- On the policy level, the benefits, outputs and impacts of specialised programmes are often monitored with indicators such as number of participants, joint activities, development over time and differentiated by target countries or groups. The openness of national programmes can be assessed through the monitoring of the share of overseas participants, share of budget going abroad, etc. The general level of cooperation activity is measured using, for example, the number and status of STI agreements, and live projects within them. Other indicators include participation in EU policy schemes, participation in international organisations and infrastructures, flows of students and technologies, etc.

It is clear that the evidence on the extent to which monitoring and the use of indicators are employed is relatively patchy and no strong examples emerge from the countries surveyed in detail. Nevertheless, their use is likely to assume increasing importance as policymakers are required to base future decisions for the prioritisation of research and for the strategic alignment of national resources for research. Therefore the project team's first thoughts on a possible future monitoring framework for assessing S&T cooperation with third countries are presented in the next chapter.

8. Towards measurement and monitoring

As defined in the preceding study on drivers for STI cooperation[26], one of the main purposes of indicators is the "monitoring of developments and the evaluation of specific measures to support international activity". A preliminary concern is to monitor how the internationalisation of the system develops. Thus, one must "employ indicators that capture the development [over time] of international engagement of the STI community in all the different modes of internationalisation and the changes of governance and organisation positions. However, because internationalisation is only an end to other goals, monitoring would also have to assess how international activity contributes to 'better' science and technological development, to competitiveness and to the societal and political goals associated with international STI activities. Thus, further indicators may need to be developed in order to support such monitoring". These 'other goals' are framed in the Literature Review for this study and are presented in the second chapter of this report. These take account of more recent policy developments with regard to STI internationalisation and are used to structure the definition of potential indicators in subsequent sections of this report.

It should also be noted that the majority of the indicators discussed in this chapter have not emerged from the country studies but have been derived in large part from the literature review and from the conceptualisation that has built on the previous study.

The objectives for which evaluation and monitoring may be applied in the context of STI internationalisation can be largely derived from the set of policy goals which underlie the purpose of STI cooperation policies, and which are defined in the Literature Review for this study. These are:

- Achieving research excellence
- Attracting/retaining/developing human resources for science & technology
- Competitiveness & innovation
- Science diplomacy
- S&T capacity building
- Tackling grand challenges

Each of these is addressed in turn below, together with the activities, which contribute to their achievement and the potential indicators that may be employed in measuring the outcome of these activities.

[26] Technopolis and MIOIR, (2009) Drivers of International cooperation in research: Final Report.

It is also important to distinguish between two major levels, or purposes, for monitoring. The first concerns the use of indicators (either qualitative or quantitative) to assess the broad level of activity with regard to internationalisation, generally either as a measurement of the *status quo* or as a benchmark for the formulation of future policy actions. The second type of monitoring is more strongly associated with evaluation and concerns the ongoing collection of data (again, qualitative or quantitative) that can be used to assess the performance of implemented policies (such as programmes, schemes, etc.).

8.1 Achieving research excellence

There are a number of rationales which underpin the objective of research excellence: particularly in smaller countries, the problems of a lack of critical mass in certain research capacities or the lack of research infrastructures may hinder the achievement of world class research excellence. Thus, access to international partners and infrastructures, through cooperation via a range of mechanisms can help to develop critical mass and overcome the lack of domestic capabilities. Excellence in research, as expressed through a variety of indicators (notably numbers of publications and citations) and less tangible factors such as scientific reputation and prestige, is also a goal in itself for the purpose of exerting influence at international fora, in attracting further leading researchers from abroad and in attracting the R&D arms of foreign companies, etc. The use of indicators such as citations and shares of co-authored publications also figure prominently in international benchmarking exercises. Studies show that internationally co-authored papers typically attract higher citation scores than do domestically co-authored papers or single authored papers and thus are a desirable outcome of publicly supported cooperation schemes due to their higher perceived impact.

As defined in the Literature Review, activities that may be used to develop research excellence (or its measurable outcomes) include:

- The promotion of cooperation leading to co-authored papers with international partners
- The promotion of publication in international scientific literature
- The overall promotion of international research cooperation
- The targeting of internationalisation policy on emerging science powers

The last of the above activities also serves the purpose of raising general awareness of national scientific capabilities in potential foreign markets, in addition to attracting high quality researchers from such countries (although most inward migration policies target the best quality people, irrespective of origin) to immigrate, while acknowledging that the balance of global scientific labour is shifting.

In order to monitor and measure the outcomes and effects of the above activities, the following can be considered as potential indicators:

- *Internationally co-authored papers (activity indicator)*
    - *Benchmarked against (e.g.):*
        - *Total domestic papers*
        - *Absolute number of domestic co-authored papers*

        - *World total of internationally co-authored papers*
        - *Competitor shares of international co-publications*
        - *Discipline shares of co-publications*
        - *Etc.*[27]
        - *Shares with authors from emerging science powers, etc.*
    - *(From above) Derived citation scores (impact indicator) compared with (e.g.)*
        - *World share of highly cited articles*
        - *Comparisons of domestically and internationally authored publications*
        - *Cross-disciplinary comparisons*
        - *Etc.*[28]
- *Shares of papers in international leading scientific journals (quality indicator)*
- *Presence and share in international research programmes/infrastructures (activity/quality indicator)*
- *External (non-domestic) applications for inward travel on mobility schemes (reputation indicator)*
- *Budgetary data on international research cooperation activities:*
    - *Gross expenditure on STI internationalisation (aggregate of next indicator)*
    - *Agency specific expenditure on STI internationalisation (aggregate of next indicator)*
    - *Programme specific expenditure on STI internationalisation*
    - *Breakdowns of above on:*
        - *Activities with specific partner countries (including third countries)*
        - *Disciplinary or 'thematic' groupings*

Possible suggested sources for this information can be found in the indicators checklist in chapter 8.8.

[27] Note: the use of bibliometric data lends itself to a range of analytical approaches, of varying levels of sophistication: those indicated are drawn from the relatively simplistic options.

[28] See previous footnote.

8.2 Attracting/retaining/developing human resources for science & technology

This objective overlaps to some extent with that discussed in the previous section although in this case the notion of mobility rather than excellence in research is more prominent. The concerns over scientific brain drain are well documented, not just for smaller economies: larger economies face 'competition' from the attractiveness of the United States in terms of its greater resources, and its breadth, scope and noted excellence in research. This attraction operates in two ways, both as a destination for domestic, high quality researchers and as the destination of choice for potential highly qualified and skilled immigrants from other countries. In addition, the notion of brain gain (i.e. the attraction of qualified researchers on a long-term or permanent basis) has now been superseded by that of 'brain churn' wherein the residence time adopts a more temporary basis leading, it is claimed, to shorter, yet more focused and fruitful knowledge exchange and opening up the domestic scientific workforce to external influences and expertise. Finally, in countries that have undergone historical diaspora, policies have sought to turn the exodus of research talent into a positive attribute whereby existing long-distance contacts may be used to develop links with the expatriates' host country (including its scientific resources) or where knowledge and skills accumulated by expatriates may be returned to the home nation. Notable examples include Greece and Italy, although Cyprus has also been active in investigating this course of action.

Several activities are relevant in meeting this objective:

- The promotion of international research cooperation
- The promotion of international mobility of researchers
- The promotion of student mobility
- The promotion of university/HE teaching internationalisation
- The reduction of researcher outflows by improving domestic conditions
- Attracting back researchers who have left to work in other STI systems
- Promoting diaspora networks ()

Again, a number of potential indicators could be developed against which these activities could be monitored and measured:

- *Budgetary data (activity indicator)*
    - *Proportion spent on mobility schemes*
    - *Balance of expenditure: inward vs outward*
- *% HRST from abroad (stocks indicator)*
    - *… as % total S&T workforce*
    - *… in universities*
    - *… by discipline, etc.*

- *... student numbers*
- *... by source/destination country*
- *Etc.*[29]

- *Flows of researchers inward/outward (flow indicator)*
  - *Absolute numbers in/out – per year*
  - *Time series comparisons*
- *Mobility schemes targeting specific countries (inward/outward) (activity indicator)*

8.3 Competitiveness & innovation

In a sense, these objectives are one step removed from the area of scientific research and hence excellence and prominence in scientific research are seen as the means to the end of improving a nation's position both in the international innovation market place and in gaining influence in international regulations and standards setting. In the latter instance, important technological advantage may be secured for domestic firms if the international standards and regulations adopted are favourable to the products and activities of domestic firms. They are also allied to the idea of gaining influence within potential emerging markets and innovation systems.

Activities related to this objective are:

- The promotion of cooperation in international regulatory or standards setting
- The promotion of RTO internationalisation – as a means to accessing a new client/technology base
- The promotion of collaborative links with rising innovation powers

The indicators associated with these activities suffer from either being highly specific, even anecdotal (regulations and standards setting) or very broad (cooperation with rising powers). In the latter case, several of the indicators proposed above could provide information if focused on the particular target countries. Other indicators include:

- *Presence of national researchers on international standards/regulatory fora (activity indicator)*
- *Linkages/MoUs between science agencies, RTOs and foreign equivalents (activity indicator)*
  - *Staff exchanges with foreign RTOs, etc.*
- *Numbers of trade missions to specific target countries (activity indicator)*
  - *Presence of national researchers on trade missions*
- *Analyses of foreign participation in domestically-organised national science, technology or sectoral 'show-case' events*

[29] Several further levels of disaggregation are also possible

8.4 Science diplomacy

Under this objective, research and S&T partnerships are viewed as a potential means of improving international relations and leveraging 'soft power' (i.e. influence over international decisions whose favourable outcome is likely to benefit domestic firms or other interests).

The major activity linked to this, rather 'soft' objective is that of the promotion of international research cooperation in general terms.

As in the previous objective, potential indicators are again rather vague or highly specific:

- *Number of MoUs and similar collaborative agreements with foreign governments, agencies (activity indicator)*
- *Presence of national researchers on significant international fora (quality indicator)*
- *Presence of science attachés or similar in foreign embassies (activity indicator)*

8.5 S&T capacity building

Again, this objective demonstrates strong interdependence with those above, particularly 8.1 (research excellence) and 8.2 (attraction/retention of human resources). In a narrower sense, the internationalisation of domestic universities can be viewed as a means to building national S&T capacity, both through the attraction of high calibre students from abroad (some of whom it is hoped will remain after their studies) and of highly qualified and skilled researchers/teachers who will directly contribute to the national S&T capacity. More cynically, the attraction of foreign students (who may be charged fees, as in the UK) can be seen as an important generator of income. In a broader sense, the development of increased domestic S&T capacity is essential to ensure that the impacts of research are shared globally.

Relevant activities here are:

- The promotion of university research/teaching internationalisation
- The promotion of capacity building cooperation.

Indicators under this broad objective can be derived as a subset of several of the indicators outlined in the Sections relating to scientific excellence (8.1) and researcher/student mobility (8.2). These could include:

- *Number of MoUs and similar collaborative/exchange agreements with foreign universities, etc. (activity indicator)*
- *% foreign researchers/staff in university research/teaching staff (activity/flow indicator)*
- *% foreign students in student population (flow/quality indicator)*
- *Publications data (see 1.2.1.1) (activity/quality indicator)*

8.6 Tackling grand challenges

The inability of single countries to mobilise sufficient research resources to deal with complex, supra-national or global challenges and issues or the need to share the, sometimes prohibitively expensive, costs of major research infrastructures is a well documented driver for international cooperation in S&T. In addition, different problems and challenges and their contributing research fields will have their own dynamics, calling for a diversity of perspectives and research expertise.

Thus, two lines of activity related to this objective are:

- The promotion of international research cooperation
- The avoidance of 'one-size-fits-all' approaches through the application of a variety of research capabilities.

A number of indicators may be used to monitor measure activities under this objective, although they are again relatively specific and would be difficult to apply in a generic fashion:

- *National membership of international research infrastructures, international programmes and scientific fora dedicated to grand challenge issues (activity indicator)*
    - *Share of operations time allocated to national researchers at international facilities*
    - *Share of national researchers in major international programmes and other activities*
- *Share of publications on grand challenge themes (activity/quality indicator)*[30]

8.7 Barriers to monitoring and evaluation

This section is specifically concerned with the difficulties encountered when trying to monitor, measure and evaluate international activities in STI. It is based on the findings of the Country Reports, with additional information from the Literature Review and from the existing experience of the team members.

8.7.1 Definitions

Evidence from a number of studies into international cooperation in STI and into mobility flows of researchers have highlighted the problems encountered due to the absence of comprehensive and widely accepted definitions of the terms and process being studied. To illustrate this, two common issues can be examined.

The first concerns the process international cooperation itself. Clearly, cooperation in international STI activities can encompass an extremely broad range of activities from the arrangements made by individual researchers to collaborate with colleagues in other countries via informal channels, through participation by individuals in programmes and schemes organised at the institutional, national or international level, up to institutional,

[30] But see caveat in Section 8.7.1.

agency or government level agreements and funding investments in bi- or multi-lateral international research initiatives. Moreover, the notion of cooperation may span active cooperation in the research process itself (working side by side at the science bench) or can be less engaged, for instance, through the sharing of facilities, material, data and expertise, and can become a highly intangible activity such as representing one's country in international fora and groupings or participating in policy discussions with foreign government officials. All these facets of cooperation (plus even more that have not been explicitly mentioned above) nevertheless contribute to the overall picture of international cooperation.

Secondly, as noted in the Literature Review: "There is also no accepted definition of international mobility, and mobility with regard to researchers is more problematic than other forms of highly-skilled worker mobility because it is does not necessarily involve migration or cross-border working. Much 'researcher mobility' involves shorter or longer research visits to research institutions, collaborators or facilities elsewhere. Studies in the literature tend to vary in the way that they define and operationalise 'mobility' thus hampering comparability".

The key point to emerge from this issue of definition is that it already puts in place a number of difficulties for the selection of appropriate indicators by which these processes may be measured. Therefore, a key initial step in the development of any set of monitoring and measurement indicators must be to **provide a suitable and widely acceptable definition of the process(es) to which they are to be applied**. This definition must align with the specific policy question or issue under examination: no overarching, one-size-fits-all definition can be provided in the absence of the context (and the inherent parameters) of the policy question. For example, if the objective is to achieve a better understanding of the level of scientific cooperation between a Member State and China, then scientific cooperation could be defined variously as: co-publication activities (in recognised scientific journals), number of persons engaged on exchange visits (of specific duration and through a set of recognised programmes). Hence, the definition chosen will influence the choice of metrics while, vice versa, the availability of suitable metrics will influence the definition.

An associated issue concerns the wish for policymakers to understand the thematic priorities expressed or implemented by other countries. Unfortunately it is not particularly straightforward to translate the S&T disciplinary fields typically used in the bibliometric data into the broader, policy-oriented themes employed by policymakers. For example, nanotechnology can encompass a range of research interests and sub-fields drawn from a broad number of scientific disciplines, including chemistry, materials sciences, physics and others. In this case, it is not possible to utilise much of the existing available quantitative measures of research activity and instead one would need to investigate softer 'indicators' such as the thematic priorities expressed in policy documents, for example.

A similar argument also applies to the identification of research activities associated with the so-called 'Grand Challenges'. Again, these are broad and convenient policy 'labels' which encompass, as suggested by their name, extensive inputs from a range of scientific disciplines and technological sectors. Hence, attempting to apply bibliometric analyses to the evaluation and monitoring of research associated with Grand Challenge issues will be problematic and again, 'softer' information may be required.

8.7.2 Data collection issues

A clear message to emerge from the Country Reports is that many government ministries, agencies and other bodies do not routinely collect information relating to the international activities they fund or support in other ways. This is particularly evident in the national level surveys and reviews that have been conducted into internationalisation activities: these make frequent recourse to bibliometric data, often gathered through specifically commissioned surveys and analyses rather than utilising data collected on a routine basis by the lead national agencies concerned – simply because such data either do not exist or are in a form that would require collation and extensive analysis. In addition, since internationalisation forms a marginal activity for many of the higher level policy bodies, agencies and organisations involved, the use of such dedicated resources is constrained.

Similarly, while aggregate budgetary data may be available to most agencies that support international cooperation activities, it is rarely available in a disaggregated format that would allow analysis of the distribution of funds between EU and third country activities for example or, if it is available, again the way in which it stored is not readily conducive to manipulation for analytical purposes.

However, there does seem to be a trend, in some countries at least, for the routine collection of data such as inward and outward student flows and the distribution of foreign versus national research staff and students. This is notably the case in higher education institutions, especially in the United Kingdom, and may be partially explained by the differential fees structure that is operated by these institutions in respect of domestic, EU and third country students, and on their reporting requirements to the Higher Education Funding Councils. Hence, in the UK, for example, aggregate and time series data is available on these statistics, at the institutional, regional and national level and can be broken down by gender and other variables.

Linked to the above problems, it is also clear that when data is routinely or periodically collected by relevant agencies and other bodies, there is still a lack of standardisation in terms of the way in which the data is collected, the forms in which it is stored and how it is actually defined. Thus, one national agency may collect data on research visits abroad using variables such as disciplinary area, destination country and funds provided, while another may collect data on project type, length of visit and age of researcher. Similarly, national research facilities may collect different sorts of data regarding the international visitors they attract and may operate such collection processes in a non-systematic way. These factors preclude any attempt at aggregation from which a national picture may be derived.

Finally, some of the above potential indicators rely on qualitative or anecdotal information. For example, the presence of national representatives on international fora offers no information concerning the level of influence they exert or the nature of the activities they undertake (i.e. from active participation to limited observer status). Similarly, the collection of information on the numbers of MoUs in operation between governments, agencies or institutions conveys little insight into the nature of the activities they cover: thus MoUs may range from specific agreements on clearly defined collaborative activities, through generic legal frameworks which facilitate more specific cooperation arrangements, to paper agreements established as political gestures or other motives (although these could be categorised as forms of 'science diplomacy').

Thus, overall, depending on the specific type of indicator selected, the provision of background data is often non-standardised and far from comprehensive and may also be in a form that precludes aggregation or comparison with the activities of other national agencies and bodies.

Based on the research conducted it is not possible to be prescriptive regarding the optimal set of indicators for policy makers to select. Such choices are expressly contingent upon the precise policy question or issue under examination: co-publication data is useful for the broad level monitoring and measurement of scientific cooperation but provides little information on governmental level policy priorities which may be better assessed through the examination of MoUs or similar level agreements. Likewise, additional information on scientific cooperation between individual researchers could be obtained from participation in specific collaboration programmes. As a further example, if it is the intention to monitor the impact of a specific cooperation programme on scientific cooperation, co-publication data would provide only a partial picture and would be dependent on the ability to attribute individual publications to the supporting programme in question.

8.7.3 Absence of comparative data

Taking the above two major types of barrier together leads to the third message to emerge from the Country studies, that is, the lack of comparability between the various levels of information, particularly at the national level. Even within the scope of the limited cross-country analyses that was conducted, the project team was unable to make any clear and meaningful comparison on any aspect of internationalisation activities. This was true even at the level of gross, national level expenditure on international activities. Whilst it is common policy practice to make international comparisons between national expenditures on R&D, it is almost impossible to make any significant comparison between countries on their spending for international R&D activities, let alone with regard to these activities with third country partners since it is generally impossible to disaggregate the underlying funding streams.

8.7.4 Scale and scope issues

In selecting the most appropriate indicators to apply, it is important to consider the level at which the monitoring and evaluation process is to be applied. For example, bibliometric indicators can readily be applied to analyses at the national level, since this data contains information on the country of residence of the author(s). However, at the funding agency level it becomes less useful since little information on the attribution of funding is available (although such data is now becoming available through the ISI Web of Science) and a more complex process is required whereby the recipients of grants, for example, must be individually identified and their relevant data extracted from the bibliometric datasets. On the other hand, whilst participants in specific mobility schemes can be identified and targeted by relatively detailed questionnaires, the results obtained cannot be easily scaled up to the national level to provide an overall picture of mobility issues.

This has significant implications for the processes involved in evaluating and monitoring the activities of individual programmes and agencies: if a national picture of international activities is required, then a degree of standardisation will be required across all the

relevant agencies and programmes to ensure that some level of comparability is achieved which will allow a degree of scaling up and aggregation. Thus, if a funding agency collects data on a range of variables relating to the researchers it funds, for example, similar variables should also be used by other agencies which operate similar types of scheme.

8.8 An assessment of indicators and process needs

8.8.1 A Potential Indicators checklist

The following table presents a brief overview of the major potential indicators or groups of indicators that have been identified in this review, with an assessment of the main benefits and problems associated with their use. It is derived from the above list of potential indicators that were identified according to the policy framework approach used throughout this report and which was suggested by the findings of the literature review. The relationship between the broad policy goals, their anticipated outcomes and the potential indicator types is presented in Sections 8.1 to 8.7 above. A 'traffic light' system has been used to indicate their overall suitability for further investigation and application.

It should be noted that the application of any indicator is highly contingent on the outcomes it is designed to measure and on the objectives of the underlying activity.

Figure 13 Indicators checklist

Indicator	type	Benefits	problems	sources	examples	feasibility
Internationally co-authored papers (and derived variables, sub-sets)	output	- quantitative, - comparable - readily available, produced by external bodies - several variables and subsets covered - broadly accepted indicator	- few apparent, but: - historic (time lag issue) - not collected for specific evaluation/monitoring purposes - does not capture full range of published outputs - requires expert collation and analysis (on large scale)	ISI Web of Science	UK (BIS – International comparative performance of the UK research base, 2009) NL WTI2 (STI indicators: http://dialogic.nl/documents/2010.056-1128.pdf) Austrian Science Fund (FWF)	Very good
Shares of papers in international leading scientific journals	output	- quantitative, - readily available - comparable	- few apparent - favours 'mainstream' science	ISI Web of Science	IT slightly different, The Excellence of products (sum of evaluations obtained by the excellent products with at least one foreign co-author), Evaluation of the Quality of Research 2004-2010 (VQR 2004-2010)	Very good

Budgetary data on international research cooperation activities:	input	- quantitative, - several variables, sub-sets, - can be aggregated	- limited availability - lack of standardisation[31] and comparability - problems of definition - open to double counting	Rarely national, mainly organisational level	VINNOVA, Sweden Fundación General CSIC, Analysis Unit, Spain The Academy of Finland	Contingent on availability - medium
% HRST from abroad	stock/ (flow)	- quantitative - several variables, sub-sets - can be aggregated/ disaggregated	- not always collected, - often non-standardised, - definitional problems	OECD STI	UK Royal Society (Knowledge Networks and Nations) The Research and Innovation Council of Finland Research and Innovation Policy Guidelines for 2011–2015. See: *http://www.tem.fi/files/30413/Research_and_Innovation_Policy_Guidelines_for_2011_2015.pdf* DE J. Edler (Ed.) (2007): "Internationalisierung der deutschen Forschungs- und Wissenschaftslandschaft"	Good – depends on availability
% foreign researchers/staff/students in university research/teaching staff	stock/ (flow)	- quantitative, - relatively easy to monitor - can be aggregated/ disaggregated	- not always collected - problems of standardisation	Rarely collected at national level	UK (Higher Education Statistics Agency - *http://www.hesa.ac.uk/index.php?option=com_content&task=view*	Medium – requires detailed collection

[31] In this sense 'standardised' implies that data is collected through similar procedures, similar types of variable are available and data is broadly comparable between data sets.

					&id=2371&Itemid=161) NL Nuffic (predominantly student mobility, http://www.nuffic.nl/en/expertise/mobility-statistics)	
Flows of researchers inward/outward	flow	- quantitative, - several variables, sub-sets	- not always collected, - often non-standardised - definitional problems	OECD STI	UK Royal Society (Knowledge Networks and Nations) IT Evaluation of the Quality of Research 2004-2010 (VQR 2004-2010) DE J. Edler (Ed.) (2007): "Internationalisierung der deutschen Forschungs- und Wissenschaftslandschaft"	Medium – requires collection
External applications to inward mobility schemes	activity /flow	- can be monitored - range of variables can be captured	- non-standardised - not always captured systematically	organisation-specific	NL NWO programmes open to foreign application, no data publically available.	Good – requires collection
Mobility schemes targeting specific countries	activity	- easily monitored, - activity indicator, - several variables	- non-standardised - does not convey weight of effort	organisation-specific	NL NWO/Nuffic (1000 PhD's China TT-China) Mostly part of bilateral research programmes: French National Research Agency (ANR) Austrian Science Fund	Medium-relatively easily collectible

					(FWF)	
Presence/share in international research programmes	activity	- readily monitored, - quantitative, - quality indicator, - several variables, sub-sets	- non-standardised - not always monitored - may not be comparable	specific to international research programmes	e.g. HFSP searchable (*http://www.hfsp.org/awardees/awards-archive*) Swedish International Development Agency DE J. Edler (Ed.) (2007): "Internationalisierung der deutschen Forschungs- und Wissenschaftslandschaft"	Very good – easily collected
Presence/share in international research infrastructures	activity	- readily monitored, - quantitative, - quality indicator, - several variables, sub-sets	- non-standardised - not always monitored - may not be comparable	specific to international research organisations	Austrian Council for Research and Technology SE Council for Research Infrastructures (RFI)	Medium – requires specific collection
Presence of national researchers on international standards/regulatory fora	quality/ activity	- reputation/quality indicator	- non-standardised, - not collected, - anecdotal	case by case (if available)	UK Wellcome Trust?	Low – limited use
Presence of science attachés or similar in foreign embassies	activity	- readily collectable	- non-standardised - not comparable		UK FCO & BIS (e.g. *http://www.bis.gov.uk/assets/biscore/science/docs/s/11-1014-science-innovation-network-report-2010-2011.pdf*)* see example NL Agency, Innovation Attaché Network *http://erawatch.jrc.ec.europa.eu/erawatch/o*	Medium – little monitoring required

9. STI Cooperation: Conclusions and recommendations

9.1 Conclusions

9.1.1 Conceptual background and rationales

The rationales (broad policy goals) underlying international cooperation in S&T identified in this study remain consistent with those in the previous study by broad policy goals, namely:

- Achieving research excellence;
- Attracting/retaining/developing human resources for S&T;
- Fostering competitiveness & innovation;
- Science diplomacy (furthering foreign policy goals through the use of S&T);
- S&T capacity building in other countries;
- Tackling grand challenges.

A range of targets/objectives for policy action can thus be identified and mapped onto these goals:

- Promotion of publishing in international scientific literature
- Promotion of international research collaboration
- Targeting internationalisation policy on promoting collaboration with emerging science powers
- Promoting the inward migration of high quality researchers via international collaboration
- Encouraging and supporting researchers to spend time abroad
- Encouraging and supporting students to spend time abroad
- Promoting university/HEI teaching internationalisation
- Reducing outflows of researchers by improving conditions in the domestic science system
- Attracting back researchers who have left to work in other systems
- Promoting international regulatory or standards-setting collaboration
- Promoting research and technology organisation (RTO) internationalisation
- Improving perceptions of the country by promoting its scientific achievements
- Pursuing foreign policy goals by promoting scientific cooperation and values
- Promoting cooperation which builds capacity in collaborating countries
- Promoting international research cooperation on grand/global challenges
- Avoiding one-size-fits-all approaches

9.1.2 Methodology

Using a relatively limited set of indicators and proxy indicators, it has been possible to provide a first order assessment of the level of international cooperation activities in science and technology for the EU Member States.

This system, when combined with additional qualitative inputs, allowed the identification of EU Member States which had relatively high levels of cooperation at the international level and provided some indication of the extent of this activity with third countries.

9.1.3 Results

1. Overall, data and information relating to MS international cooperation activities typically exhibit a large variation in terms of both availability and level of detail offered. Moreover, the availability and detail of information relating to MS international cooperation activities with third countries is much lower and, in some cases, almost non-existent. This applies to:
    - Internationalisation strategies (which range from non-existent to relatively specific)
    - The key actors involved in internationalisation governance, which exhibit a mix from single lead actors to coordinated efforts, to diverse actors and activities, the last of which is often influenced by the sets of policy drivers involved
    - Some general higher level of commonality can be seen in the policy priorities in operation:
        - Most countries reviewed have selected geographic priority areas/countries
        - Less attention is paid to thematic priorities

2. A range of instruments and measures are employed through which internationalisation policy is implemented:
    - Bilateral agreements and MoUs: these vary in their content and scope – several cover third countries.
    - Multilateral agreements and programmes: these can be highly specific in terms of their targets and modalities
    - Mobility schemes open for extra-EU participants: a very common and specific instrument – several cover third countries
    - Partnership programmes and initiatives: again, a very common, specific and focused instrument – and several schemes targeting third countries can be identified
    - Foreign branches or subsidiaries: common but exhibit variation in the type and level of activity – the presence of such instruments in third countries can be readily identified.

3. Financial data on international cooperation would ideally provide a strong indicator of related activity and effort. However, there are a number of problems:
    - Data on S&T expenditures at the national level, while available and relatively standardised, is rarely disaggregated into activities related to international cooperation, let alone cooperation with third countries.
    - Budgetary data for individual agencies, councils, etc. is also often readily available but again suffers from a lack of disaggregation into international

cooperation activities. Again, the picture for third country activities is worse.
- Budgetary data for specific cooperation instruments is available, on a case by case basis but involves collection problems
- Many of the problems concerning the lack of disaggregation noted above stem from the fact that much international cooperation in research is driven from the bottom up, particularly through responsive mode research funding programmes. Moreover, the international aspects within research grants often remain 'hidden' and are infrequently collected by research agencies.
- The increasing tendency for research agencies to 'mainstream' internationalisation efforts (i.e. not to separate such activities from all other facets of research funding) militates against the collection of relevant budgetary data
- There is also a tendency for cooperation programmes and other instruments to address multiple objectives (e.g. science and development, or research and education), which further precludes the precise attribution of budgetary data
- Nevertheless, based on the limited financial data that was available, it is possible to group the reviewed MS according to: overall expenditure on international S&T cooperation with third countries and trends in expenditure on international S&T cooperation activities with third countries.

4. As expected, bibliometric data appear to offer a very useful approach to assessing levels of international cooperation between countries in terms of identifying major partner countries, research focus and trend information. Since they are the product of individual collaboration activities they reflect the bottom up nature of international S&T collaboration very well; on the other hand they do not necessarily reflect top down policy priorities. Their disadvantages are that they are historic, are less adequate in expressing science-industry or industry cooperation patterns and reflect only one aspect (research co-publication) of the full spectrum of research cooperation activities.
5. Rather surprisingly, their use among the reviewed MS was found to be rather limited to international benchmarking exercises and little routine use for monitoring purposes was encountered.
6. In terms of the use of indicators:
    - A number of the reviewed MS reported the use of assessments of national internationalisation activities in S&T although few reported the use of specific indicators. Examples of these included: Foreign students as % of all students in higher education; Foreign-born researchers as % of total R&D personnel; Share (%) of foreign-owned companies of total turnover of the business enterprise sector; Funding received from EU 7th R&D Framework Programme per thousand researchers; Accepted projects in EU 7th R&D Framework Programme (number of projects / GDP); International co-operation in patenting: patents with foreign co-investors (% of all); bibliometrics (co-authored publications and relevant citations).
    - Only one of the MS reviewed reported the use of indicators to monitor the progress of S&T internationalisation objectives. These were: Quota of scientific production in respect of world total (%); scientific production in

international cooperation (%); economic return on national participation in EU R&D Framework Programmes (%).
    - Very few agency-level monitoring exercises on international S&T cooperation activities were reported.
    - Evaluation of individual programmes relating to international S&T cooperation was reported as quite widely established. However, most of the examples tended to focus on issues of scientific quality, with publication data tending to form the most commonly applied indicator.

7. Based on the above analyses, the project team has proposed a list of potential indicators that may be applied in the context of monitoring MS' activities in S&T international cooperation, both with regard to intra-EU and third country activities. These have been categorised against the following broad policy goals, although significant overlap between the categories is inevitable:
    - Achieving research excellence
    - Attracting/retaining/developing human resources for science & technology
    - Competitiveness & innovation
    - Science diplomacy
    - S&T capacity building
    - Tackling grand challenges

8. The project team has also identified a number of barriers to the use of indicators for monitoring and evaluation purposes, which will need to be addressed:
    - The absence of accepted definitions of widely used concepts, particularly in respect of: S&T cooperation and international mobility.
    - Variation in the understanding of disciplinary and thematic boundaries and the contribution that specific fields of research and technology make to the idea of 'Grand Challenges'.
    - A lack of routine monitoring and collection of data relating to international S&T cooperation activities by national agencies and governments, although there does seem to be a slight trend towards an improvement in this area.
    - Variation between different indicators, which range from hard quantitative measures of specific activities, to broader less well defined or standardised measures, and even 'anecdotal' evidence.
    - A lack of standardisation and comparability between many of the indicators and data collected.
    - Problems of scale and scope: some indicators can be applied at the country level, whilst others are only applicable at the level of individual instruments.

9.2 Recommendations

Based on this study, and with regard to its primary objective of attempting to contribute to the design of a potential system of indicators for the monitoring of MS international S&T activities with third countries, the project team proposes the following recommendations:

- Derive accepted definitions: A key initial step in the development of any set of monitoring and measurement indicators is to provide a suitable and widely acceptable definition of the process(es) to which they are to be applied. As noted above, it is necessary to provide an improved definitional framework for concepts such as 'international cooperation' and 'international mobility'. These do not have to conform to globally accepted definitions but should be defined with regard to the purpose of the evaluation or monitoring exercise being undertaken in order to set clear boundaries and scope.

- Clarification of the purpose for indicator design and use: It is essential that there is a broad understanding and acceptance of the role of the indicators. In particular, the key policy questions to which the indicators are expected to contribute should be made explicit and indicators which directly (or as directly as possible) address these questions should be identified.

- Prioritisation of key indicator requirements: It is suggested that, having identified the key questions to which the indicators may be applied, a short list of prioritised indicators are selected, based on an assessment of cost effectiveness.

- Systematic Monitoring arrangements: Where additional data and information is to be collected (for example, by Member States, or by expert contractors) a set of comprehensive guidelines outlining the definitions, variables and data parameters to be applied should be produced in order to achieve clarity of purpose and standardisation of collection approaches.

- Allocation of responsibilities and oversight: In the event that Member States' authorities are tasked with data collection, particularly if this involves a range of actors, clear responsibilities should be defined and a lead agency/actor appointed for the oversight of the process.

Additional methodological recommendations include:

- Derive a framework typology for instruments: most instruments include several modalities, target more than one policy goal or target group, and so forth. Thus, policy measures are difficult to group according to their modalities (mobility schemes, MoUs, S&T agreements, etc.) since, for example, mobility schemes are often part of an agreement or MoU, joint programmes are broader and may include mobility modalities, and these mobility programmes in their turn largely differ in size, scope, target, and so forth. Another possible way in which to group these policy measures is to link them to the policy goals and targets that have been set at the different levels by governments, agencies and HEI institutions.

Appendix A Decision table and scoring system

Category	Score	Indicator
A – Strategy		
	3	Dedicated formalised extra-EU internationalisation strategy
	2	Dedicated formalised internationalisation strategy
	1	International cooperation key element in the main national RTDI policy document
	0	None of the above
B – Actors		
	1	Specific agency in charge of international cooperation activities
	0	No specific agency in charge of international cooperation activities
C – Agreements		
	3	Relevant and strategic partnerships with key third countries and significant budgets
	2	Relevant partnerships with a range of third countries
	1	Low level of agreements and target third countries, seemingly no vibrant partnerships
	0	None of the above
D – Instruments		
D.1 Mobility schemes	**1**	General mobility schemes open to extra-EU
	0	No general mobility schemes open to extra-EU
D.2 R&D projects	**1**	General R&D project schemes open to extra-EU
	0	No General R&D project schemes open to extra-EU
D.3 International attachés	**1**	International attachés
	0	No International attachés
E – Output		
	1	Percentage share of internationally co-authored S&E articles worldwide > 3 % (NSF, 2010)
	0	Percentage share of internationally co-authored S&E articles worldwide < 3 % (NSF, 2010)
F – Third Country perspective	**1**	Key target partner for more than 4 selected 'third countries/regions' based on literature review
	0	Key target partner for less than 4 selected 'third countries/regions' based on literature review

Appendix B Overview of instruments and policy objectives of EU-12 - EXAMPLE AUSTRIA

	Achieving research excellence	Attracting/retaining/developing human resources for science and technology	Competitiveness and innovation	Science diplomacy	S&T capacity building	Tackling grand challenges
Bilateral intergovernmental agreements and MoUs	FWF (Science Fund) funds joint projects with other science funders in partner countries	BMBF together with partner funds mobility of researchers in selected projects	BMVIT Cooperation agreements in infrastructure technologies to establish contacts for furthering economic and technological relations and exchanges			
Mobility Schemes		Lise-Meitner Programme – improving the know-how of the scientific community in Austria			-Erwin Schrödinger Fellowhip – funding postdocs to gain international experience -Translational brainpower programme – tap and utilise knowledge of foreign researchers in research projects. -ASEA Uninet – supports the knowledge exchange between partner universtities in Europe and South-East Asia by exchanging scientists and postgraduates	
Partnership programmes and initiatives			-Joint economic Commissions, Expert committees and Working Groups preparing access to foreign markets -Go-International to encourage companies to do business abroad -FFG Competence Headquarters programme to attract international R&D companies or units to Austria -Joint BMVIT and BMWFJ 'COIN programme' to improve innovation performance focused on foreign companies who want to work with Austrian partners on R&D and networking projects			The Appear programm – to improve quality of teaching and research, management and strengthen scientific dialogue. Main focus on poverty reduction, research for development, water supply and sanitation, etc.
Multilateral agreements						
Foreign branches or subsidiaries				S&T liaison offices in Washington DC and Beijing		