Study on Ireland's International Engagement in Science, Technology and Innovation, Module 1 Report

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MODULE 1

Revised Final Interim Report

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Content

1 Introduction - Scope and purpose of this report

The major purpose of this study is to develop a conceptual framework for decision making in public policy on how best to support Irish researchers, research institutes, and companies in their international research activities. Given the strength of current globalisation pressures, the breadth of available options and the costs and benefits of different public policy instruments, the selection and effective implementation of targeted measures is critical.

Much can be learnt from public internationalisation activities adopted in other countries. First, in order to make sense of the practices in place in foreign innovation systems and to structure our analyses meaningfully, 'internationalisation of research needs and related policies' has to be defined and categorised. In this study we will use the following working definition of 'international research activities'. These consist of:

targeted actions undertaken by individuals or organisations with the aim to generate, exchange or exploit new scientific-technological knowledge abroad or in collaboration with foreign partners.[1]

This report is the result of the first module of the proposed study. It provides background knowledge on the internationalisation of research and research systems and assists in learning from current policy activities in other countries. It delivers a framework for the different modes of internationalisation dealt with in this study, both in terms of research activity and in terms of policy-making. This aims to reduce the complexity of the issue to its fundamental components. Further, in highlighting the benefits of international activity in general, it lays the ground for public action in the first place.[2]

Chapter 1 of the report contains an overview of current international activities based on available data. It focuses on a selection of indicators of both industrial and public research. Understanding major ongoing trends is a fundamental prerequisite for policy decision making. It implies on the one hand an illustration of the emerging global patterns of internationalisation and on the other hand a discussion of the main drivers and enablers as well as barriers and risks. This is vital, as policy-making is about dismantling barriers, controlling for risks, strengthening the enablers and exploiting benefits.

Chapter 2 will then summarise the main findings of the activities in six countries. It does this along a set of policy dimensions and contains detailed accounts of practices in other countries whenever they provide lessons or food for thought for concrete action. These practices are presented in boxes throughout the chapter.

Chapter 3 draws together some general lessons. It brings together the conclusion from the general developments (chapter 1) and the country practices summarised in chapter 2 and outlined in more detail in the annex (see below). At this stage, it does not present an analysis of the Irish situation, but instead lays the foundation for further parts of our study where evidence of rationales and outcomes of internationalisation policies from other countries will be directly related to the Irish context.

The annex to this report summarises the findings of country case studies. Based on internet and document research and, most importantly, in-depth interviews, the report gives a summary overview on principle

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1 This includes the inflow of foreign researchers to stimulate research within a country. Collaboration shall be defined in its broadest sense here, not only side-by-side research in a lab, but exchange of data, co-publication, joint complementary project work etc.

2 This is the second draft of the report, which tried as best as was possible in the given framework to react to suggestions of the steering committee. The study team is grateful for these suggestions, which have been extremely constructive.

strategic orientations in the selected countries. Further, it highlights major trends and especially good practice in these countries in terms of the major dimensions of importance in our context:[3]

- international organisations,
- foreign presence and monitoring,
- the meaning of Europe,
- priority setting mechanisms,
- inter-administrative co-ordination and
- evaluation of international activities.

[3] Given the scope of module 1 of this study, the report cannot claim to assess the strategies and situations in depth, rather it will provide insights and good ideas for the development of a concept in the other modules of this study.

2 Literature Review

2.1 The breadth and limitations of the relevant literature

A first, very general finding of the literature review is that although data on international activities by companies and scientists, is abundant, the literature for our specific purpose described above – policies, is very limited. The bulk of the literature is on industrial R&D, comprising general trends on internationalisation of research labs or off-shoring of certain research functions (e.g. most recently UNCTAD 2005, OECD 2005a, 2006a, 2006b, European Commission 2007). These studies and reports contain trends in the geographical distribution of R&D-related foreign direct investment, future scenarios for these distributions, changes in company motivations and models, the importance of general framework conditions and the like. For all these aspects of industrial R&D, there is an increasing number of studies and articles on trends, motives of companies, consequences of activities of Multi National Companies on national innovation systems, etc. (see Edler/Polt 2008, Rama 2008, Sachwald 2008 for an overview of recent literature[4]).

However, although *public research* faces a large number of new challenges and opportunities in terms of internationalisation, and indeed internationalises in many new and intensified ways, the related literature on policies for collaboration is also very limited. In terms of specific country studies, only for the UK (Technopolis 2005, and partly GSIF[5] activities), for Germany (Edler et al. 2007) and Finland (Halme et al. 2004) do we have systematic studies.[6] In terms of mobility of researchers and skilled workers, a range of European and OECD activities have been conducted, mainly within the perspective of brain drain – brain gain (e.g. MERIT 2003), and this issue is increasingly on the agenda of European governments. Also of relevance is a study undertaken for the European Commission (the RESCAR[7] project), which analysed career paths of young researchers in major areas of European research (social sciences, engineering, and life sciences). The study was undertaken to inform Commission policy on the European Research Area, in particular, in regard to human resources in research, with a focus on skills and stocks of researchers and their mobility.

However, the availability of consistent data and indicators is relatively scarce with the consequence that cross-country comparisons – precisely those exercises that should indicate best practices – are particularly difficult. Further, prospective reports outlining the *potential* benefits of alliances and networks of public R&D institutions outnumber by far the studies aimed at evaluating public policies for international collaborations. The result is that much of the literature on the internationalisation of public R&D tends to be normative in nature, often draws inferences from analyses of business R&D and seldom addresses empirically the question of impact. Reasons for this must certainly include the aforementioned lack of systematic data, measurement problems and difficulties in taking a long-term view of internationalisation dynamics.

The *literature on relevant policies* to internationalise the domestic research system and to best take advantage of global capacities and developments is much more limited. This is especially true when it comes to internal decision making on how to prioritise, what measures to set up and how to coordinate

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4 Some recent examples include Rama 2008, Sachwald 2008, Molero/Alvarey 2006, Sadowski/Sadowski-Rater2006.

5 The Global Science and Innovation Forum (GSFI) is a forum for the discourse on internationalisation of industrial and public R&D and related policy. It will be dealt with in detail in later sections.

6 An extensive English summary of the German study has been provided to the Steering Committee of this study and relevant results of this study will be incorporated below.

7 "Collection and analysis of existing data on Researchers Careers and implementation of new data collection activities", IPTS/ETEPS AISBL, 2007

them. In terms of industrial R&D, which is not in the focus of this study, it is clear – as noted in an OECD conference on globalisation 2 years ago – that the best policy to attract foreign R&D is to create conditions that suit companies in their R&D activities in general, with no negative discrimination for foreign companies.

In terms of specific policies, beyond some anecdotal evidence, little systematic work has been done to ascertain the rationale for and impact of strategic choices in this area. Edler / Boekholt (2003) have tried to systemise domestic policies and delivered a set of case studies[8]. A recent study on Germany has also tried to analyse the meaning of various policy tools and policy framework conditions for international activities of mainly public researchers (Edler et al. 2007), while a similar approach has been taken for a study in the UK (Technopolis 2005). In terms of existing research programmes – and thus for one important pillar of R&D policy – there are two studies that assess the effectiveness of programmes in terms of international research activities (Halme 2005, Optimat/VDI 2005). The latter (Optimat/VDI 2005) not only looks at programmes, but also at programme designs in order to assess potential improvements in policy-making. Recently, the CREST committee within the EU has launched an internal survey on international strategies, activities and principles in EU member states, which has not been published, but could be examined at during the course of this study.[9] An evaluation of COST was undertaken in 1997 (PREST et al. 2007). This examined, *inter alia,* quality issues (including impact), the benefits of and barriers to widening participation (to the countries of central and eastern Europe), COST as a catalyst for long term S&T collaboration (including additionality issues and network formation), and participants' investments. Overall, however, the data we have on international activities and the role of framework conditions and policy support programmes is scattered and unsystematic.

2.2 Modes, drivers and enablers of engagement in international science and innovation

A popular taxonomy of the different forms of internationalisation of R&D (Archibugi and Michi, 1995) broadly distinguishes:

1. International exploitation of innovations generated within national borders, for example through technology exports via licensing and/or trade of international property rights so that a foreign organisation can develop and/or exploit abroad the innovative output of national R&D systems;
2. Global generation of innovation, which involves foreign direct investment in R&D by multinational enterprises aimed at producing or acquiring R&D output from locations other than their country of origin;
3. Global techno-scientific collaborations for the joint cross-country development of new knowledge, products and services.

Other studies adopt a sharper focus on public R&D and provide a finer articulation of the relevant modes of international engagement in science and technology (Edler et al. 2007, Technopolis Report 2005). The following instruments, whose utilisation is by no means mutually exclusive, are identified:

- Mobility of researchers (public and private), which can range from a short term, multiple week research stay to an indefinite move abroad

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8 Again, the steering committee of this study received a summary article of this work, major conceptual thoughts will be presented below.

9 Eight years earlier, CREST had already discussed a study on national programmes and international activities and concluded that action to improve the situation would be needed (Technopolis et al. 1999)

- Creating new knowledge through international S&I collaborative activities (generally in terms of collaborative projects, but this could also imply common, multilateral programmes (Human Frontier Science Programme)
- Taking advantage of or providing international research facilities for joint or individual usage or being member of international research organisations
- Monitoring international S&I developments, whereby systematic action is taken to scan international developments in terms of research and related policies and to inform stakeholders, about opportunities and developments abroad
- Acquisition and exploitation of international S&I resources in the home country (for the science and the *innovation* system![10]).
- Exploitation of national S&I in foreign markets, which as a rule relates to companies, however, increasingly also to research organisations

There is no shortage of literature on the expected benefits of cross-country collaborations in S&T and authors are to a great extent in agreement on the main drivers behind them (among the more recent publications, see for example Archibugi and Iammarino 1999; Edler at al. 2002; A. Little 2005; Wagner and Leydesdorff, 2005; UN 2005).

Public R&D institutions are involved in cross-border R&D activities to facilitate acquisition of state-of-the-art know how, mainly to fulfil their own research mission, but if those are linked to national strategic goals, international activities can contribute to the attainment of those policy goals. The pursuit of new knowledge abroad can be motivated on the one hand by the opportunity to access foreign markets, in which case the collaboration tends to aim at better understanding the characteristic of local demand, but also to gain reputational spillovers from joint research with partners of prestigious international standing. At the same time, joint R&D tends to entail the sharing with partners of the costs, and risk, especially when large infrastructures are needed for basic science (e.g. particle accelerators) or product development (e.g. international telecommunication networks). The combination of competences located in different countries also bears the potential to find solutions of complex scientific and technical problem that could not be solved with domestic resources alone. In addition, access to funds from foreign institutions open to international bidders can work as a strong incentive for engaging with partners abroad, as well as for accessing pools of skilled individuals that might have an interest in pursuing opportunities for research in another country. Finally, some international activity stems from the nature of the research subject, such as natural or social phenomena, etc. which is limited geographically (i.e coral reefs, archaeological sites, indigenous populations, etc.). A contributing part of the rationale for international activities may also reflect a desire to influence regulatory regimes or standards, or may be viewed as a 'ticket' which permits participation in international debate on a scientific or technological issue.

Recent systematic data for internationalisation on the level of research institutes and Universities exists for Germany (Edler et al. 2007). Taking all research establishments including universities into account, there are two important types of motive. The *first* is to access and utilize excellent and complementary knowledge. The second is to secure *EU funding*. There is surprisingly little difference between basic and applied research institutes when it comes to their motives. The German research establishments apparently have no broad strategies to recruit foreign staff. Cost advantages thanks to cooperation with foreign partners do not, as yet, play any role. This contrasts starkly with current strategies in the industrial sector, where firms have increasingly discovered cost-based reasons to relocate research or engage in research cooperations abroad (Sachwald 2008). Lastly, it appears that for a large proportion of the application-oriented institutes, reaching out to foreign firms and keeping step with German firms abroad are important

[10] See section below on the value of international public science for the innovation system.

motives. After all, supporting German companies abroad is important for a third of the application-oriented institutes.

On the individual level, again the German study on public scientists has found that the vast majority of researchers experience a net utility gain from their international activities. Internationalisation helps German and foreign researchers to make a name for themselves and step up their performance (publications, co-operations). They see a direct link between internationalisation and their own careers in research. International activities accelerate knowledge generation, avoid duplicated work, increase competencies and increase researchers' (measurable) output (Edler et al. 2007). In a much smaller scale study on scientists in the UK, the major drivers have been access to external capabilities (mainly foreign colleagues (49% of all respondents), but also foreign facilities (26%)) as well as access to foreign funding sources (41%) (Technopolis 2005, p. 28). Seeking complementarities and excellence a well as additional financial sources (EU) are the major drivers for UK researchers, enhancing reputation, in contrast to German scientists, has been less important.

In terms of changes in the framework conditions for international activities, next to EU framework programme and related activities (EUREKA, COST) a set of specific policy initiatives such as high skill-sensitive immigration policies and the introduction of schemes for funding international R&D have been increasingly important. Again in Germany it was found that most of the international activity is funded by the standard basic science foundation project, which enable and encourage international activities within national projects (Edler et al. 2007). On a general, non-policy level, the diffusion of ICT has facilitated the development of international projects. ICTs have certainly played the role of a general purpose technology behind the growth and transformation of global S&T networks, not dissimilarly to the complementary function exercised by the English language as a pervasive 'social' technology.

This discussion already implies an extreme level of complexity, as international activities are complemented by the wide range of governmental measures to support and facilitate international research activities. Given the range of actors in industry and public science, given the multitude of ministerial missions (foreign policy, development policy, industrial policy, science policy, education policy), given the importance of legal framework conditions (mainly immigration, pension and labour laws) and given the variety of institutional missions and context conditions, the role that public policy plays to support, facilitate as well as hinder these activities and their fruitful development is extremely complex. And we also have to keep in mind that public policy will affect scientists and their institutes as well and firms in their research activities. Thus all action taken must fit into the rationales of scientists.

2.3 The importance of international public research for the national innovation system

The major share of policies and programmes relevant in this study concerns public research and its related international activities. One dimension largely neglected in the current discourse on internationalization of industrial R&D is the role of international activities of public research organisations and researchers. Given the above-mentioned increasing importance of the quality and accessibility of public researchers as a location factor for companies, this is a pertinent issue. This debate needs continuation and differentiation, as international activities of public research institutes and Universities support the location advantages of a given innovation system in various ways.

The recent study on Germany (Edler et al. 2007) shows that institutes embedded into the international generation of knowledge, providing for international exchange of their students and researchers, are much better prepared for international activities within the home base. If the staff in public research institutes is internationalised (through mobility or international cooperation), they are better equipped and inclined to cooperate with international companies, both within and outside their country. This immediately results in a higher attractiveness of the science base for international companies and thus in positive effects for the national and even more regional innovation system in which the institute is located. Furthermore, the German study has shown that being abroad as a student or young researcher significantly enhances the likelihood of international cooperation and mobility during the subsequent career. This not only enhances the attractiveness of the science base for international companies, it also paves the way for a broader

spillover effect of international activities within the host country, as the likelihood for embeddedness, exchange and absorption increases.

In addition, internationally active public research organizations often follow companies in their international re-location activities in order to serve them locally. They thus embed themselves in the local knowledge production and development in new research markets. In doing so they assist diversification strategies of national companies, realising some contract research benefit (monetary and intellectual) for the national science base and they also serve as a transfer mechanism of knowledge about new developments abroad back into their home systems. International diversification of public research institutions may thus, beyond the immediate effects on the revenue and position of institutes, lead to spill back processes beneficial for the home country innovation system.

International public research institutes can serve as transmission belts to those companies that cannot or do not want to afford to go abroad themselves or to co-operate internationally as much as they would need. For example, there is evidence that innovative SMEs are far less often engaged in international cooperation than innovative MNEs (EUROSTAT, 2004). Knowing that a public research partner is integrated in international knowledge networks is an asset for any local company which may reap benefits from internationalization at low costs. In the view of research institutes that work in contract research for industry international activities serve their SME clients at home. Of those German researchers asked about the benefit of their international activity for the innovation system, 48%answered that they transfer the knowledge gained to German companies, while 54% reported that through their international activities they have improved their service for local companies, to be better prepared when working together with local customers. The percentages are even higher if the purely basic research-oriented researchers are excluded (Edler et al., 2007).

In sum, if public research institutes are internationalised in terms of personnel (mobility), trans-border cooperation or even physical presence abroad, they can be the pipeline for global knowledge for local SMEs, monitoring and re-transferring knowledge from abroad and thus contributing significantly to increasing the overall effects of internationalization for a system.

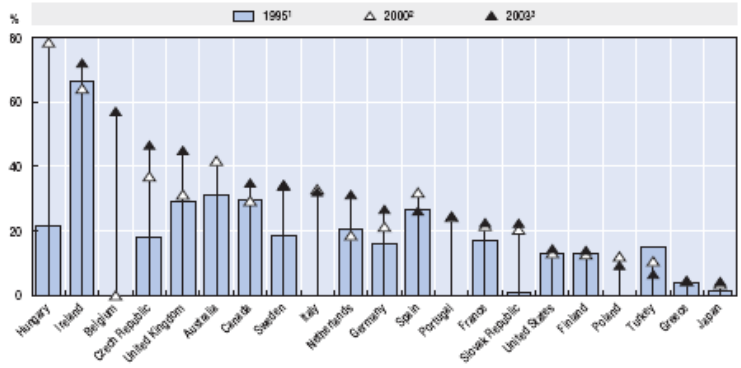
Consequently, public policy can have large leverage effects if it takes care of the conditions under which public research institutes can internationalize their activities and their staff, in both directions. To set incentives and to dismantle hindrances for doing so is a major means to boost internationalization of research on a broad front and to enlarge the benefits within the innovation system at large. And again, public policy – everywhere – needs a sound understanding in terms of the role it can play both as regards the pre-condition for embedding foreign companies within a system and as regards the meaning of international activities of all kinds on the overall benefits on the competitiveness of innovation systems.

2.4 Patterns of internationalisation

This chapter seeks to give a very broad overview on the global development in terms of international R&D, as a background for policy and strategy. Overall, evidence points to an aggregate rise in the levels of internationalisation of private and public R&D. There is increasing investment in S&T activities in fast-growing economies and China, above all, adds to the total worldwide stock of R&D and reduces the aggregate geographical concentration of S&T activities. In parallel to this, the number of cross-country collaborations in S&T is also increasing and their patterns of growth are rather neatly captured by classic indicators of S&T activities such as patents records and scientific publications.

Given the broad knowledge we have on the globalisation of industrial R&D, two statistics may suffice as indications. First, the importance of the international mobility of industrial R&D for countries has increased. As is well shown in Figures 1 and 2, Ireland is at the forefront of this development, which implies high attractiveness, but at the same time a high dependency.

Figure 1: R&D expenditure of Multi National Companies



1. 1996 instead of 1995 for the Czech Republic; 1997 for the Netherlands, Finland and Turkey.
2. 1999 instead of 2000 for Ireland, Spain, Germany, Greece; 1998 for Hungary and France.
3. 2002 for Sweden, Italy, the United States, Turkey, Japan; 2001 for Germany, the Netherlands, Finland; 2003 for other countries.

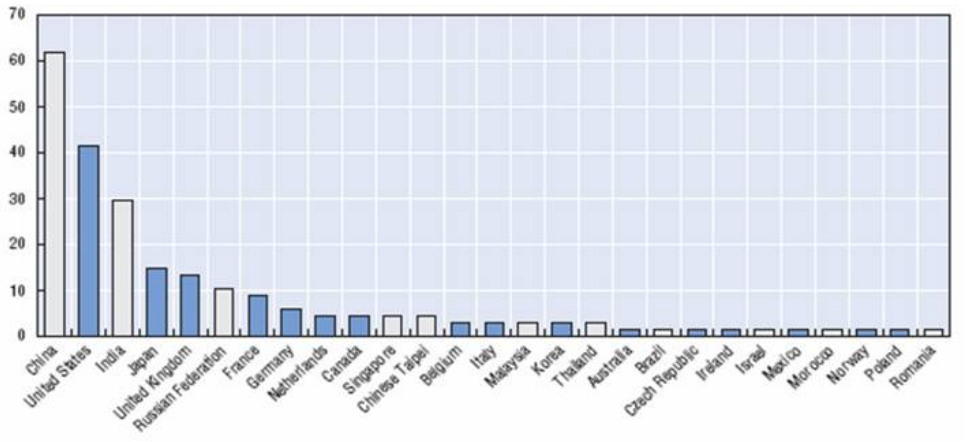
Source: OECD AFA database, June 2006.

R&D expenditure of foreign affiliates 1995, 2000, 2003as percentage of R&D expenditures of enterprises

Figure taken from OECD 2006, p.10

Figure 2 shows that large international companies will invest in additional R&D largely in Asia.

Figure 2 : the future direction of international industrial R&D



Share of companies indicating the country will be the most attractive R&D location 2005-2009

Source: UNCTAD 2005

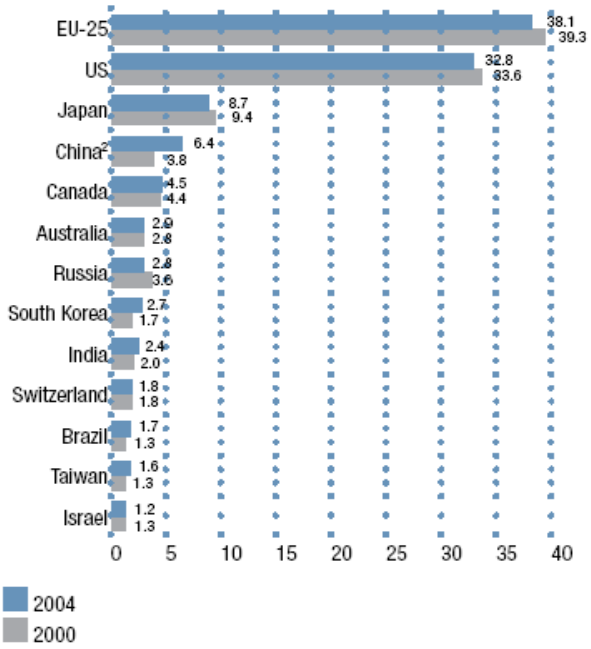
Table 1 is extracted from a very recent report from DG Research (2007). It shows significant increases in applications for patents to the European Patent Office by a number of countries, indicating a significant average rise in the volume of global research output for which property rights protection was sought in the years 1995 and 2003. A look at the relative shares of the global stock of patent applications for the two years reveals clear downwards trends for Europe and the US, a marginal increase for Japan, and – in absolute terms still relatively small scale increases for countries like South Korea, China, India, Taiwan and Brazil. Similar trends characterise the dynamics of global science as indicated by the growing number of papers published in recent years. Table 2 is also drawn from the same EC source. It compares the years 2000 and 2004 and points to enormous rates of growth, Even if all this is, in absolute terms, still much lower than the established markets and cooperation partners, diversification is obvious, and continues..

Table 1 – European patent applications by country 1995 vs. 2003

Total patent applications to the EPO by priority year				
	1995	2003	1995 share	2003 share
Total World	83 817	163 011	100.0%	100.0%
EU-27	35 335	62 250	42.2%	38.2%
US	28 293	48 786	33.8%	29.9%
Japan	13 301	27 987	15.9%	17.2%
South Korea	551	5 400	0.7%	3.3%
Switzerland	1 872	3 113	2.2%	1.9%
Canada	1 217	2 736	1.5%	1.7%
Australia	905	1 958	1.1%	1.2%
China (excl.HK)	120	1 898	0.1%	1.2%
Israel	502	1 587	0.6%	1.0%
India	41	1 003	0.0%	0.6%
Russian Federation	309	641	0.4%	0.4%
Taiwan	107	572	0.1%	0.4%
Norway	358	533	0.4%	0.3%
Singapore	61	416	0.1%	0.3%
South Africa	125	415	0.1%	0.3%
New Zealand	158	376	0.2%	0.2%
Brazil	87	348	0.1%	0.2%
Mexico	40	145	0.0%	0.1%

Source: DG Research
Data: Eurostat

Table 2 - World shares of scientific publications [(1)]



Source: DG Research
Data: Thomson Scientific / CWTS, Leiden University
Notes: (1) Full counting method was used at country level. At the aggregate level, double countings were avoided; (2) CN: Hong Kong is included in the data for 2000.

Recent bibliometric studies have disaggregated total research output and identified directly the contribution of *international* scientific collaborations in science. Table 3 compares statistics of papers co-authored by scientists located in different countries as indicated by the addresses of their institutions of affiliation for the years 1990, 2000 and 2005. As the aggregate number of outputs grew over the 15-year period considered, so did the number of internationally co-authored papers, as one would expect. The most salient information, however, emerges from the simple computation of relative shares reported in the last

column. It indicates that *proportionally the contribution to global S&T output of international collaborations increased from 8.7 per cent of total output in 1990 to 17.4 in 2005*.

Table 3 – Global cross-country collaborations in science 1990, 2000 and 2005

Year	Unique documents in SCI	Addresses in the file	Authors for all records	Internationally co-authored records	Addresses, internationally co-authored records	Percent internationally co-authored documents
2005	986,831	1,696,042	3,301,251	171,402	618,928	17.4
2000	778,446	1,432,401	3,060,436	121,432	398,503	15.6
1990	590,841	908,783	1,866,821	51,596	147,411	8.7

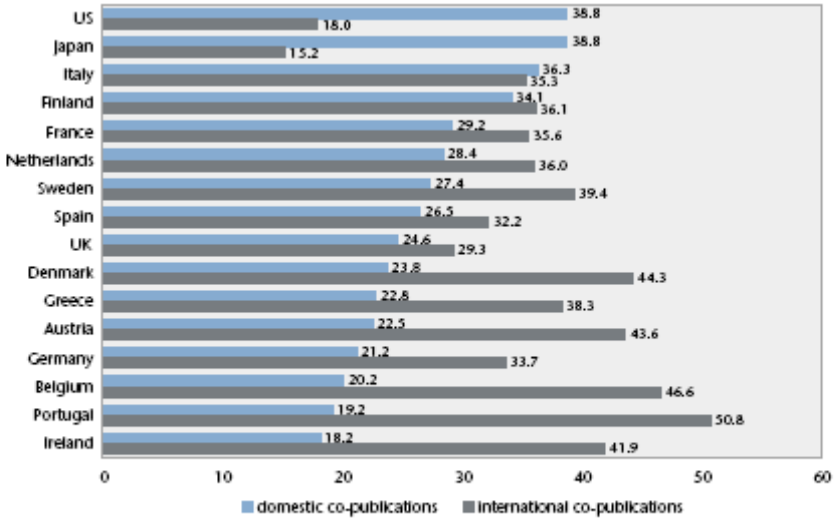
Source: Wagner and Leydesdorff, 2005

It is obvious that although science has always been international, *the internationalization of public research is increasing in a dynamic fashion and will further increase in importance*.[11] Some basic figures from two recent surveys on public research institutes (including Universities) and individual researchers in Germany may suffice here for illustration (Edler et al., 2007): The share of international co-publication out of all publications has increased. For Germany, for example, almost 40% of all scientific publications are international co-publication, almost a doubling between 1991 and 2003. Except for humanities, the increase is true for all scientific areas. Furthermore, almost two thirds of all German researchers surveyed had been abroad for research purposes. For individual researchers international activity is essential for their career development. 43% of all non-University institutes and 68% of all Universities claimed to have an internationalization strategy.

Across various countries, the level of international co-publications varies (European Commission 2003, p. 303 – 304, see figure 3 below). The smaller countries (Portugal, Belgium, Denmark, Austria and Ireland) show the highest share of international collaboration, while some larger countries, mainly ÙK, US and Japan) are much less internationalised in terms of international collaborations. This does not mean that scientists of smaller countries collaborate less in total (domestic and international), but whenever they collaborate they have a much greater need to search for partners abroad. Thus, for Ireland, for example, 42% of all publications are in cooperation with foreign partners, but only 18.2% are with domestic partners. With the advent of more global locations that are accessible and suited for international cooperation, this ratio may further develop in favour of international collaborations. Access to global partners thus is keay for scientists especially from smaller countries. Further data compiled by the EU also shows that international collaboration does not concentrate on European partners, in almost all fields the majority of international co-publications entail at least one non European partner.

[11] It must be noted, however, that a limit might emerge in the light of the fact that rate of growth of the share of internationally co-authored papers appears to be decreasing over time.

Figure 3: share of domestic and international co-publication in all publications - countries



Source: DG Research
Data: ISI, NSB 2000
Note: Sorted by decreasing share of domestic co-publications.

Source: European Commision 2003, p. 3030

Not only does the share of international co-publications grow, even more importantly, the *impact* of international collaborations – one measure for scientific excellence and relevance – seems to have grown significantly. *Bibliometric data indicates that international activities pay off*. The number of citations received by papers after publications can be used to approximate the level of impact the findings have had among peers. Table 4 (from Glänzel et al., 2006) results from citation data gathered for papers among whose authors at least one was located in the US, Europe, Japan or China – the 'Tetrad' – Korea, Chinese Taipei, Brazil and Turkey. The figures show that international collaborations systematically display above-average performances.[12] In addition, while for the EU15, the US and Japan, a slight decrease is observed, all other countries in the table register upwards trends. Several other studies have demonstrated that those papers that are internationally co-authored are also more highly cited (Narin *et al*., 1991; Lewison and Cunningham 1991; van Raan, 1997; Roberts, 2006).

[12] Superior performance here implies impact in terms of readership. Whether this implies research of superior quality is a controversial aspect of the academic debate.

Table 4 – Impact of international collaborations in science 1991 vs. 2003

Evolution of the Relative Citation Rate of internationally co-authored papers of the Tetrad and four dynamic countries

	1991		2003	
	All papers	International scientific collaboration	All papers	International scientific collaboration
EU15	1.04	1.21	1.04	1.18
US	1.07	1.22	1.1	1.21
Japan	0.97	1.19	0.94	1.1
China	0.67	0.85	1.02	1.11
Korea	0.72	0.91	0.94	1.1
Chinese Taipei	0.75	0.89	0.87	1.12
Brazil	0.75	1	0.86	1.05
Turkey	0.62	0.85	0.9	1.17

Source: Glänzel, Debackere, Meyer (2006, p. 10).

Mobility of researchers constitutes another factor contributing to the growing internationalisation of science and technology. A 2006 report from the Directorate for Science, Technology and Innovation goes to some length in analysing the main trend of researchers' mobility within the limitations of available data. While noticing that migratory flows of highly-skilled workers is not a new phenomenon, it finds that the emerging institutional arrangements of a complex global labour market for advanced knowledge and skills are accelerating the rate of mobility and that in turn this is positively correlated with the technological upgrading of innovation systems.

The MERIT survey published in 2002 indicated that the US is the most popular destination for graduates seeking career opportunities abroad due to better salary conditions, prospect of swift career advancement and access to top-of-the-range facilities. The study reported that between 1991 and 2000 three-quarters of holders of doctorate degrees in science and technology of European origins planned to remain in the US. The National Science Foundation (2004) also found that the percentage of foreign born employees with doctorates in S&T reached 30% and that 450,000 members of staff of research institutions came from abroad. The high attractiveness of the US indeed raised concerns in terms of too high a reliance on foreign S&T talent in the country. . As of 2003 (data from the European Commission), in the EU15 area there were a total of 466,000 highly skilled workers employed in S&T jobs employees were of foreign origin and that half of those had come from extra-European countries outside of the EU15.

Among the major determinants of the choice of country of migration, language is an important factor especially for English and Spanish-speaking researchers, together with geographical proximity, links of cultural and historical nature (e.g. old colonial ties such as between France and the Maghreb, and the UK and Australia, Canada and New Zealand (Cunningham et al, 1998 –'S&T in the UK'), the presence of dedicated schemes and the enforcement of favourable immigration policies (DSTI, 2006; Schubert and Glänzel, 2006). Overall, barriers to international mobility seems to have been lowered significantly. In contrast to the developments in the US (see above), the risk of 'brain drain' (see for example the 2006 OECD report on the internationalization of business R&D, OECD 2006a) is therefore real, with problematic consequences especially for smaller economies that cannot guarantee top-of-the-range salaries and research facilities. In some scientific disciplines, having access to international research facilities is indeed a major factor in the attractiveness of countries as location for mobile researchers.

2.5 Barriers and Risks

The single most important barrier for internationalisation of public research is the lack of financial resources and mobility constraints of human resources. However, this seems to differ between countries

and levels. In the German study a lack of resources has been shown especially for research institutions and Universities, who claim that additional activities to become more attractive and to engage in more international activities strategically would need additional basic funds that they simply do not have (Edler 2005. In the UK, individual researchers tend to claim a lack of sufficient resources prevents them from participating in international activities (see Technopolis, 2005).

Table 5: The importance of barriers for international engagement of UK scientists

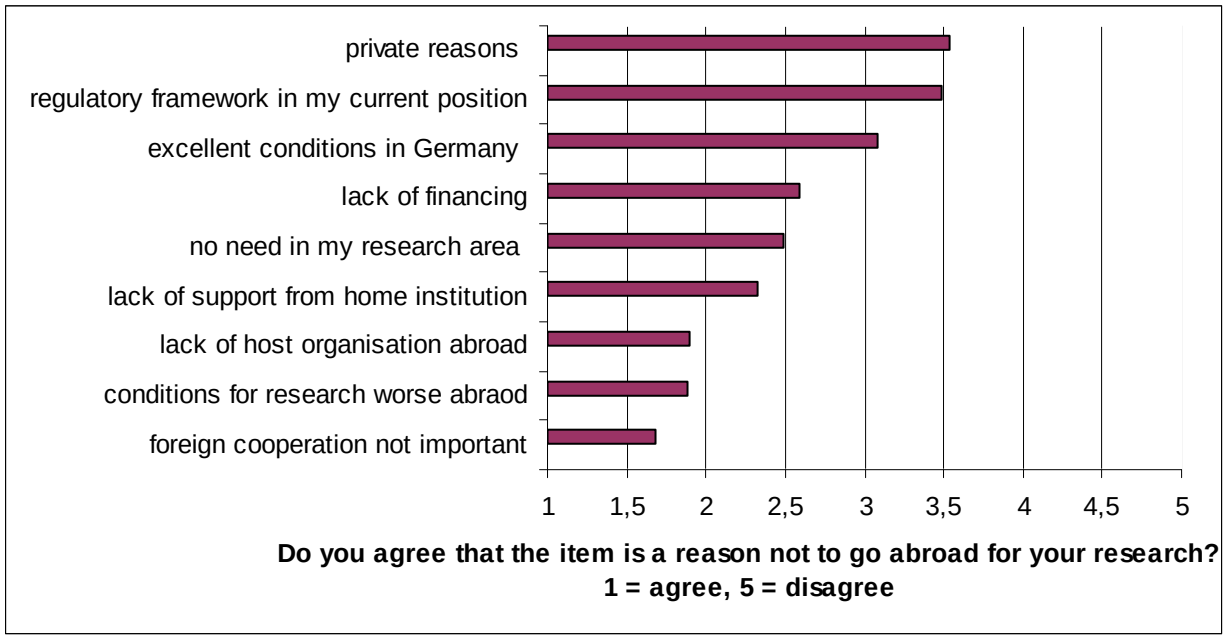
	Proportion of respondents citing	Average Ranking
Financial barriers		
Funding issues / financial constraints	49%	1.9
High transaction costs	22%	2.5
Cost/benefit ratio	6%	1.8
Exchange rates	1%	4.0
Internal barriers		
Internal human resource constraints	28%	2.0
Lack of opportunity	14%	2.5
Mgmt issues	6%	3.6
Intelligence issues	4%	2.3
Bridging / compatibility barriers		
Bureaucracy / complexity in funding mechanisms	29%	2.0
Lack of suitable frameworks / mechanisms	14%	2.5
Language / communications issues	7%	2.1
Variations in practice / standards	4%	2.5
Time-zones	1%	3.0
Legislative barriers		
IPR issues	19%	2.0
Other legislative issues	18%	2.3
Target country barriers		
Lack of infrastructure	8%	2.1
Instability / risks	4%	3.6

Source: Technopolis 2005, p. 53; the percentage indicate % of actors citing the issue as a problem, average ranking is the average this issue was attributed with 1 being the most important impediment. The lower the number, the more problematic is the issue.

A German survey has looked especially at the impediments of international *mobility*. Here, two results stand out: first, the German research system generally offers good conditions for researchers, and there are no endogenous reasons to go abroad. Second, the framework conditions are a stronger impediment than the funding: interviews revealed that administrative hurdles are often difficult to overcome by science administrators as they fall under the remit of other regulators. One of the most important factors is the non-compatibility of pension schemes and other social security schemes, which has become a major hindrance especially for post-docs.[13] In addition, for public and private research the potential leakage of important knowledge, brain drain and the actual costs of international action are further issues that lower the likelihood for international activities.

[13] Our systematic knowledge of hindrances is still very limited. For that reason, the EU is currently commissioning a study on hindrances for mobility of scientists within Europe, to be finished until mid of 2008.

Figure 4: The importance of barriers for international mobility of German scientists



Source: Edler et. al. 2007, new graphical display

A different set of problems reflects the different historical development of national innovation systems. Path-dependent technical choices might have created wide gaps between the structure of domestic competence bases and the specialisation patterns of more dynamic economies at the forefront of global R&D. While interaction with them could in principle be beneficial, limited absorptive capacity of the laggard country can prevent effective exchange of that advanced knowledge that would be most valuable for innovation in high-tech markets. The localised and 'sticky' nature of knowledge can work against international collaborations. Not all knowledge can travel effectively across borders: tacit knowledge must be generated through first-hand experience or exchanged through close personal interaction at high costs. It cannot be replicated at a distance in spite of the pervasiveness and flexibility of ICTs. It is also possible that in the face of limited funding for R&D, the allocation of increasing shares of the budget on international activities can overstretch domestic capacity and ultimately weaken the innovation system.

2.6 Policies to support international activities

Typologies

When discussing strategies, policies and programmes concerning internationalisation of research, we need a simple framework to categorise and make sense of them.

A first dimension of such a typology is *the purpose of the international activity* of scientists and firms as just outlined above. Discussion and developing policies to improve international activities and their efficiency must start with these considerations of the different purposes. A very simple taxonomy distinguishes between being more effective and efficient in generating and transferring knowledge

- in a certain field (science driven),
- to solve a certain problem (problem driven) or
- to contribute to economic development (economy driven, or development policy).

Further we can distinguish policies in terms of the *direction of knowledge flow* (Boekholt/Edler 2003). Thus there are policies

- to *attract* foreign scientists (and firms active in research),
- to *better absorb* knowledge that is created abroad (which includes monitoring, the contribution to international scientific activity
- to support scientists in their activities abroad (including international facilities) and in their international collaboration and networking efforts and taking advantage of international facilities (support of domestic scientists abroad).

While these types above are of a first order, e.g. concern the direct effect for science or the economy, some horizontal, additional aspects cut across which are more policy or even politically driven. These include programmes driven by diplomatic and foreign policy considerations, international activities driven by the motivation to influence standards, or indeed activities to show presence. However, all of these considerations will most likely be linked to the first order types above, rather than substitute for them.

Trends of international public policy activities

This chapter does not discuss the country cases (see chapter 2 and annex), rather it summarises some trends in public policy strategy and programming as regards internationalisation of science systems. It is mainly a bullet point summary of the major findings of the recent CREST working group that have been summarised in a 170 pages report (CREST 2007)[14] and of a study on international activities within national porogrammes (Optimat / VDI 2005). For obvious reasons, only the major findings can be reported, details on country level will be given only in chapter 2.

Strategies, concerns and policy action – the CREST working group report

Out of 22 countries reporting on internationalisation strategies within the CREST study, 10 claimed to have a comprehensive strategy in place, three of which as part of a general globalisation strategy (DK, RO, BE), 7 as part of their S/T strategies. Apparently 8 countries are in the process of defining a strategy. From our own findings in the interviews, the impression is confirmed that there is an enormous interest in strategy building, but at the same time strategies do not appear to be operative and are not used to guide the actions of policy makers. While there are new discourse structures and explicit strategies in place and many, also novel, important activities stem from strategic considerations, overall coordination, goal setting, visions, road maps and re-adjustment of action lines are still the exception rather than the rule (e.g. our cases of Finland and the UK who both claim to have an internationalisation strategy). Strategy development and, in particular, implementation remains more of a promise than a reality in most of the countries (CREST 2007, p. 12-14).

The drivers for internationalisation strategies are very similar across the countries reviewed, and there appears to be a canon of drivers widely shared within the European countries (CREST 2007, II-III): In general, the most important drivers are: (1) strengthening (domestic) excellence through access to existing excellence and facilities abroad, to increase the attractiveness of domestic systems (inward mobility), (2) preparing the ground for domestic innovations to be marketed abroad, and (3) to contribute to the solution of global problems.

[14] The CREST report is a very valuable source of information. However, on its basis it is hard to judge the content, seriousness and meaning of all those measures and strategies that are reported, and it is not fully clear how different categories of activities in detail look like and differ between the countries.

However, the countries recognise that there are pitfalls in engaging in international activities, such as IPR issues, brain drain (instead of brain gain or circulation), the relocation of key companies or scientists to other countries and regions. Thus, strategies need to be developed that ensure the embedding of companies and research organisations in the domestic system, to broaden the impact of international activities for the system as such, to stress brain-circulation concepts, or to monitor and make accessible the knowledge abroad for domestic actors.

The CREST group concludes that to overcome the obstacles standing in the way of a broader internationalisation concept, discourse within the government and with all kinds of stakeholder must be intensified and existing policy mix and framework conditions be re-examined in light of the international challenges and opportunities.

Priority setting within internationalisation strategies in terms of countries and fields has been classified along six rationales. These are, to some extent, mirrored in the more or less explicit prioritisation activities in our country cases (below): (1) expected scientific benefits, (2) political / diplomatic reasons, (3) market access, (4) mobility gains, (5) reputation / promotional aspects, (6) specific geographical, historic, linguistic and cultural ties (CREST 2007, IV-V). It must be stressed that although each of these reasons has its justification, our country cases reveal that they are often not compatible and a major source of frustration in international science policy making stems from a lack of coordination between the different responsible ministries. The CREST report claims that a new trend for coordination between ministries is visible, especially when it comes to specific issue areas such as water, energy, etc. However, experience within this study team, in many countries and on European level for many years, indicates that given the widespread distribution of responsibility for science and innovation, coordination is far from sufficient.

Further, the CREST report confirms our own findings (reported below) that the thematic priorities are either not set explicitly, or only set *ex post*, i.e. after country targets or modes of activity have been decided upon. In other words, there are not many strategies for certain scientific disciplines or issue areas, rather, strategies are about overall goals, horizontal activities and country foci.

The lack of comprehensive, recursive strategy development is also apparent in the data given by the countries on evaluation and monitoring. Formal evaluation of publicly supported international cooperation activities is the exception rather than the rule. Exceptions are the participation in the Framework Programme and European programmes such as COST and EUREKA and a limited set of multi-lateral programmes such as the Human Frontier Science Programme. This may be an indicator that internationalisation, while being a policy concern for many years, has only recently come to the full attention of strategic policy makers as a dimension of S&T policy making that cuts across most activities and must be exploited much more strategically (internationalisation as an "emerging pillar" CREST 2007, p. VII).

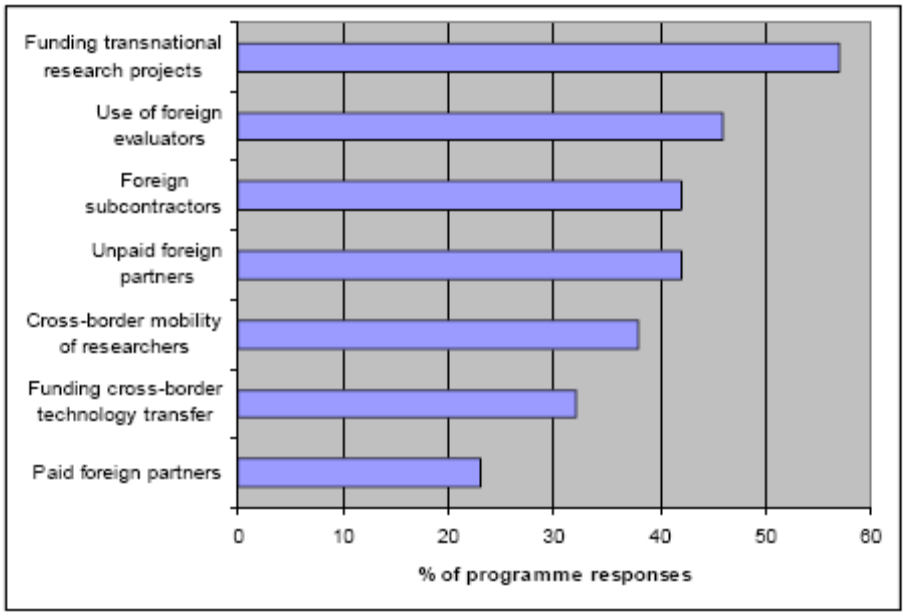
Possibly the major area of concern – and increasing activity – for policy makers is mobility of researchers. There seems to be a development from avoiding brain drain to establishing brain circulation. This reflects the insight that not only gaining foreign researchers, but also exposing domestic researchers to foreign science systems is beneficial for the science system as such.

In terms of attracting foreign companies (rather than individual researchers), there has been a shift in recent years towards not only attracting them, but embedding them, striving for spill over effects into regional or national innovation systems as such. One example for this is the Austrian Headquarter Strategy Programme, which seeks to link specific incentives to attract leading R&D labs of multi-national firms with the provision that they engage in domestic cooperation, with other firs and with public research (see Annex to Austria). However, while these intentions are genuine, policies to embed companies, even with financial incentives, are extremely challenging, and from all anecdotal and academic evidence a simple rule follows. Those systems that are strong in scientific and / or technological terms, that have built up networking traditions and accessible public research organisations and that do not discriminate negatively against foreign actors are best equipped to make foreign industrial R/D activities spill over and stick to the country (Edler, J. et al. 2006).

International activities in national programmes

The CREST report does not, strangely enough, engage in a discussion on the openness of national programmes, although this could be one of the most straightforward means to increase international activity (cooperation and inward mobility) in line with achieving existing programme goals. One reason for this might be – and this is admittedly speculative – the functional specialisation in the member states, with international activities being a horizontal activity that is often not fully backed or even coordinated by vertical thematic programme owners. While there is enthusiasm to take advantage of international dimension in specialised units of ministries, the thematic programmes are often introspective and perceive the international dimension as a threat to their remit or control. However, a study commissioned by the EU reveals some current practices. The figure below depicts the results of a survey done for the European Commission, which asked national programme owners about these various models within their programmes. One has to keep in mind, however, that the share of the budgets that are spent on international activities within national programmes is still below 5% (Optimat/VDI 2005), i.e. while programmes tend to be open in principle, the investment in international activities is still very low. The CREST report does not, interestingly, systematically discuss the rationales and activities vis-à-vis international large scale facilities and European infrastructures. In this regard, the countries show more awareness of the importance to be engaged in these organisations through national personnel.

Figure 5: Relative prevalence of modes of international activities in national programmes



Source: Optimat / VDI (2005), p. 10.

2.7 International coordination in public policy towards internationalisation

Apparently, the EU is the prime location for coordination of public policy for EU member states. Within the last 5 years a range of new activities has been started at the European level that has fundamentally altered the possibilities of international coordination of policy. In terms of international collaboration in science and its facilitation, this has two related, but distinct dimensions. First, policy is coordinated within Europe to facilitate collaboration between EU Member States and their public and private researchers. Here, we have a range of well established mechanisms such as the intergovernmental EUREKA

(application oriented) and COST (strategic, curiosity driven networking) schemes, the supranational joint research centres and large scale facilities and, above all, integrated Framework Programme, under the Community method. The latter is by far the most important means of international collaboration in S&T. In addition, there is a still limited set of activities that try to foster collaboration with actors from outside the EU, formerly through the horizontal INCO programme, meanwhile as an option within the various actions of the Framework Programme.

Within the last five years, a new set of policy coordination mechanisms has been established that is of utmost importance both for intra-European and for extra-European S&T activities. The attempt is to go beyond the facilitation of European wide collaboration in the Framework Programme and strive at the coordination of national programmes (e.g. ERA-NET) and policies (Open Method of Coordination). The EU Commission is currently planning a strategy for international collaboration that includes rationales and provisions for coordination of national policies and programmes.[15] In the context of this study this is of crucial importance, as the supply of public support (financial and framework conditions) as well as the uptake and demand by Irish scientists must take into consideration the possibilities that are offered in terms of joining forces with partners. To do so, a range of *different modes of coordination* are possible:

- aligning goals with partners (on the basis of a shared diagnosis) in order to prepare for synergies
- structured information exchange and learning
- harmonisation of national frameworks, common frameworks
- opening up or adjusting national activities (complementarities, synergies, e.g. one scientific facility? abroad, joint information systems, etc.)
- joint action to
  - facilitate exchange, networking
  - facilitate collaboration (new money spent), and
  - to "integrate" (e.g. bringing capacities together into a new whole, e.g. Art. 169, ERANET joint calls).

Interestingly, the CREST group, being by definition and mission 'European', sees the *European* instruments to co-ordinate science policy and funding as only a means of internationalisation if the ERA-NET has the explicit function to reach out to non-European partners. Seven out of the 71 ERA-NETs do this explicitly, and a recent presentation within the European Commission claimed that many of the other ERA-NETs have developed, over time, an understanding that coordination within Europe can make the coordinated countries more attractive as partners to non-European countries and more capable of engaging in common activities with them.[16] Thus, ERA-NET could not only offer a means to engage in multilateral international activities within Europe (as some countries strategically do) but also a mechanism to engage with non-European partners.

The CREST report highlights a set of obstacles, identified by EU countries, to their coordination of joint activities towards third countries, including: differences in national legislation, lack of administrative capacities, lack of awareness of stakeholders about potential benefits, and dominance of the competition mode over the coordination mode within countries. A range of activities is being proposed within the CREST group, ranging from the identification of targets for coordination, to the raising of awareness and

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15 The Commission has set up an expert group on that behalf and organises a series of workshops, one of which was on coordination of National policies and programmes, attended by J. Elder, MIoIR/PREST, September 19 and 20.

16 Presentation of W: Wittke, European Commission, Brussels, 19. September 2007.

establishing a specific forum for international activities and finally, to efforts to design and implement coherent approaches between countries and the EU (CREST 2007, p. XII-XIV).

3 Summary report on country cases

This section summarises some major findings from the interviews and document analysis that have been conducted in 7 selected countries[17]. The selection of countries tried to combine cases, which in terms of size and ambitions resemble Ireland. Further, the country selection covers those countries that appeared to have interesting approaches:[18]

Austria:	small, central Europe, new creative initiatives and new strategy development
Switzerland:	small, central Europe, non EU, highly internationalised in terms of inward mobility
Finland:	small, periphery, high performance, front runner in strategy development
Netherland:	small, Western Europe, high performance, colonial past
UK:	large, English speaking, new discursive efforts
Germany:	large, new strategic efforts

3.1 Strategic considerations

Overview

First of all, internationalisation has now become a strategic issue in many of the EU countries. This is a very recent development. In an OECD survey of member countries three years ago, only three EU countries had an international policy strategy (OECD 2005b). In the recent CREST survey conducted in spring 2007, roughly 15 countries claimed to have an internationalisation strategy[19]. There is thus an apparent trend towards a more systematic understanding of the role of public policy in terms of international scientific and technological developments and the role of the countries in the international division of labour. However, this trend is recent, and most "strategies" are promises rather than policy guiding concepts. Apparently, across the 22 countries covered by the CREST survey, the variety of approaches is enormous in terms of their coverage (breadth, depth, level of concreteness) and in terms of process (horizontal coordination for the strategy vs. strategy paper stemming form the responsible unit of the science or research ministry). The CREST working group has differentiated three types of countries[20]:

(1) countries with a general globalisation strategy with an *embedded* innovation and science strategy (the examples being Denmark and Sweden (under development Denmark),

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17 The six listed here plus Denmark, for which a mini-case study has been developed late in the project due to initial difficulties in finding suitable informants.

18 At the outset, the study team tried to gather information on Israel and New Zealand. New Zealand has not been accessible and not answered our request in time and through the relevant persons. For Israel it has turned out that the country not only is not fully accessible, but also has a unique position in terms of partners and strategic priorities (security) that would make a transfer of policy lessons challenging. It was thus decided not to cover Israel. This however did not affect the overall number of countries covered, the number is as high as suggested in the proposal to this study.

19 Interview Arie van der Zwan, CREST working group o internationalisation, and internal note prepared by the CREST group May 4.

20 See the analysis provided by Zwan and Tierlinck, 2007.

(2) those with an explicit internationalisation strategy in Science and Technology, not part of a general globalisation strategy,

(3) those with internationalisation strategy (or concepts) as part of a broader STI strategy.

The increasing importance and perceived need to have strategic approaches is also reflected in the countries surveyed in this study. All countries have developed or are developing strategic documents for international S&T. Finland has been one of the first countries to develop a broader strategy that was even introduced as a good practice in an OECD conference 2005. The country developed basic principles in order to take advantage of globalisation of S&T on a broader scale. Interestingly, Finland concentrates on building up domestic strengths that enable domestic players to take advantage of international activities and at the same time strengthens the attractiveness of the country for international firms and excellent researchers. A second important pillar is the opening of newly designed national programmes.

The UK follows a discursive approach. The Global Science & Innovation Forum (GSIF) is an attempt to gather strategic intelligence both in terms of public research (Technolpolis 2005) and industrial R&D (Arthur D. Little) and then reflects on policy and potential venues (GSIF 2006). This is a soft strategy process, with definition of priority

In Switzerland, there is no written strategy yet, and no broader strategy is planned. The main pillar of the future activities is an initiative on bi-lateral developments. Further, the country has clear budgets designated to international activities, and the justification of these expenses is linked to structured internal discussions mainly around the budget on the European Framework Programme – which from the Swiss perspective is of course by far the most important "international" activity. The fact that the country is only associated to the Framework Programme has the positive side-effect in terms of regular public debate. Every four years there is an intensive effort to analyse and debate the cost-benefit ration of participating and spending an enormous share of the budget for S/T. Judging from personal involvement (Bieri et al. 2005)[21]. This regular discourse is helpful not only for concrete decision making, but also to reflect upon priorities of international activities and public support.

In Germany, after two years of preparation, a central strategy is now to be published very shortly. This strategy seeks to give a set of concrete aims. Although it is formulated within the Ministry of Education and Research only, it seeks to reach out to cover the positive consequences of international S&T for the innovation system. It also sketches concrete steps to increase the German contribution for global problem solving.

Austria plans to implement what would be the most elaborate strategy in terms of country focus. The country has commissioned a study to assist the strategy development. Austria has a strong focus on a multi layer country strategy, with intensive linkages especially to Eastern and Southern neighbours, taking advantage of historic ties and the geographic situation.

In a general assessment of the strategic developments in the six countries one can conclude that these strategies still have very general goals, and most of the goals are not operationalised, i.e. the fulfilment of targets could not be checked systematically. However, the countries are increasingly trying to build their strategies on some sort of analysis, be it discursive (GSIF, UK) or analytical (e.g. Germany, partly Austria). The UK and patly Germany are the only countries with a systematic, direct stakeholder involvement.

[21] J. Edler has been member of the central panel preparing the decision of the Swiss Parliament in Bern, May 11 2006.

Major rationales

On the basis of the strategic documents, the major rationales in the strategy documents are very similar. Public support needs to create and improve the conditions under which researchers and their institutions (public and private) operate. In general, they seek to support trans-border collaboration to take advantage of complementary knowledge and skills abroad, including access to facilities and talent. In recent years, the `development` rationale has become less compelling. And while the foreign policy rationale is still important in its own right, increasingly countries realise that multi- or bi-lateral agreements for scientific collaboration need to be grounded in mutual scientific interest. Moreover, the economic rationale has become more important for all of the countries, whereby international activities are supposed to directly support the national innovation system and the domestic actors (one point in case being the NL and partly Germany). In this vein, there is a tendency to "strengthen the strengths" (because of win-win with partners) and to create domestic clusters that are attractive (Fin, NL, D).

In terms of concrete concerns and actions taken, there is a movement towards ever more attractiveness. All countries ask themselves how they can become more attractive as a location for international actors. Therefore, there are manifold attraction schemes, ranging from all kinds of scholarships (e.g. the well coordinated German schemes for elitist (AvH) and regular scientists (DAAD)) to schemes for the attraction of `distinguished professors` (Finland) and finally to attracting core research competencies of large multi-national companies (Headquarter Strategy, Austria).

The country strategies, however, do not integrate the strategic activities of the large research organisations. For example, there is no top down steering of institutes or Universities in terms of the inward or outward mobility of staff. This reflects, of course, the autonomy of these organisations in our sample countries. While this leads to a variety of strategic and operational international activities, there is an apparent lack of coordination from bottom up. The strategic papers seem to recognise this to some extent, but not systematically. In Austria, a network of Universities is supported in which organisations join forces to work with Asian partners or within selected Asian countries. In contrast, in Germany there is no systematic coordination between research organisations beyond the regular exchange of information on international activities

In terms of using national programmes to finance and support international activities, the activities are mixed at best (see also above, section 1.9). In principle, foreign partners have to finance their own participation in national programmes. However, there are a range of exceptions to this rule, and some countries encourage participation of foreign partners by giving the national partners additional incentive (e.g. ProInno II in Germany, a networking programme for SMEs and research institutes). There are some forerunners like Austria, where a rather new programme (CIRCE) can be seen as a radical experiment in which trans-border innovation networks are financed, with up to 40% of the funds being transferred to the foreign partner abroad (e.g. does not have to be an Austrian partner abroad). This instrument is used as a means to combine market development (in terms of supply chain) and build up of knowledge transferring networks.

3.2 The coordination challenge

The challenge of improving co-ordination in Finland

The size of Finland mean that co-ordination costs are arguably lower than for other countries and the Nordic consensus culture tends to ensure that once decisions have been made, actions will be implemented. Thus specific new formal co-ordination mechanisms have not been proposed in the 2004 Finnish high-level strategy on internationalisation – rather the emphasis is on each actor improving their co-ordination with the others in the normal business of governance. Nonetheless co-ordination within the Finnish system remains a major concern for the Science and Technology Policy Council (OPM):

"At system level, the interaction of national policy advice and political decision-making will be strengthened. To this end, a new Government decree on the Science and Technology Policy Council of Finland came into force at the beginning of 2006: the term of the Council has been changed to correspond to the electoral period; the secretariat of the Council has been enforced; and key sectoral research fields will be taken into account in appointment of ministerial members to the Council. Within the Government, the Cabinet Committee on Economic Policy will handle the central issues in relation to science, technology, and innovation policy. Once every electoral period, the Government provides the Parliament with an opportunity for a comprehensive discussion bringing together these policy sectors… The key expert organisations in the public research system in Finland are the Academy of Finland, Tekes, and Sitra (the Finnish National Fund for Research and Development). Intensification of their interaction is important, particularly with a view to enhancing the impact of research and innovation funding and creating functional entities larger than the current ones."

Science, Technology, Innovation (Science and Technology Policy Council, 2006)

A common feature of all strategies is that they – as far as we could judge from the data gathered – seem to suffer from a lack of coordination. This is even felt to be the case for Finland, amongst the earliest adopters of a formal strategy towards internationalisation and a small nation in which co-ordination costs are thought to be relatively low (see box, above). For the main ministries, economy/innovation and science/research, this is a reflection of a more fundamental coordination challenge in S&T policy that can be observed within all OECD countries (Braun 2008, OECD 2005 c-e). All in all, the strategic documents as for internationalisation do not seem to be fully coordinated either. Apparently, the coordination problem within countries is even greater when it comes to internationalisation, as foreign ministries, ministries for economic cooperation and/or development, ministries of the interior (pension, immigration) all have their own priorities and stakes. The record from the documents and the interviews is mixed when it comes to coordination of these diverse actors. In some cases the coordination has been reported in interviews, but is not really visible in the documents, in other cases the coordination seems simply to avoid interference or to minimise the damage done rather than a pro-active approach to maximise the overall benefit. In fact, in more than one country the interviewee clearly stated that the activities by one ministry (often Foreign Ministry) or even the Heads of State often do not fit the scientific priorities of the leading ministry at all. Integrative approaches, even if initiated by ministries not responsible for scientific activities and support, are rare. Further, there are no inter-administrative bodies specifically dedicated to coordinate international S&T activities. In Germany, such a body is envisaged, and in Switzerland, there is a steering committee for coordination of ministries. This committee also deals with internationalisation of S&T whenever this appears necessary. The body which comes closest to horizontal coordination between ministries, and indeed to inclusion of stakeholders, is the GSIF in the UK (see box, below).

The UK Global Science and Innovation Forum

The UK has a series of networks and agencies promoting STI internationalisation according to different policy objectives, many of them long-standing and relatively independent of direct ministerial control. The key actors include:

- *The Royal Society* - the UK's national academy of science, promotes basic research links through its international programmes and builds links with other national academies of science through agreements and memoranda of understanding
- *Research Councils UK* - the umbrella organization for the UK research councils- promotes mobility and joint programmes and initiatives in basic research
- *The British Council* - the publicly funded by independent agency promoting British culture and education promotes internationalisation activity through its offices worldwide (and a network of

dedicated science officers in selected countries)

- *The Foreign and Commonwealth Office Science and Innovation Network* - comprises dedicated staff in 39 missions in 24 countries and territories, co-ordinated by a Science and Innovation Group in the Foreign and Commonwealth Office in London.
- *UK Trade and Investment* - promotes the UK as a location and partner for innovation activities as part of its mission to promote trade and inward investment into the UK

These various ministries, agencies and semi-independent or independent bodies are brought together in the **Global Science and Innovation Forum (GSIF)**, chaired by the UK Government's Chief Scientific Advisor. GSIF has agreed four strategic objectives for internationalisation (see below) and set out broad priority targets in terms of regions and countries. Part of the GSIF mandate from Government is to take a more evidence-based approach to high-level strategy-making and GSIF has already commissioned bibliometric[22] and other studies[23] to support policy-making in this area. There are also plans to use horizon-scanning/foresight approaches to explore different future scenarios. The four GSIF priority areas[24] are:

- Research excellence - through strengthened international collaborations and attracting the best researchers to the UK;
- Excellence in innovation - through UK businesses accessing international science and by attracting international R&D investments to the UK;
- Global influence - by using international science to underpin foreign policy and as a tool to promote bilateral partnerships; and
- Development - using research and innovation to meet international development goals, in line with the recent UK White Paper on *Eliminating World Poverty*.

GSIF provides a co-ordination forum and has no direct executive function beyond co-ordination, broad strategy-setting and commissioning evidence to support decision-making. Decisions relating to individual initiatives are still taken by the relevant ministry or agency. Rather, the forum allows the various actors in the policy system to improve their mutual understanding of each other's different roles (and different policy drivers) in what is a highly complex division of labour, The **Government Office for Science** (GoS, formerly the Office of Science and Innovation - OSI) provides the secretariat for the GSIF. There is also an active 'officials' group parallel to the main Forum which meets regularly and handles more day-to-day co-ordination. It is expected that the creation of the new **Department for Innovation, Universities and Skills**[25] (in which GoS sits), in bringing together innovation and basic research policy with higher education policy in a single ministry, may lead to further improvements in the co-ordination of internationalisation activity.

Similarly, up to now *no systematic* effort has been taken *to coordinate between countries*, i.e. to join forces with other countries in order to realise synergies when it comes to international activities with third countries. Interestingly, on the level of individual programmes coordination takes place both in terms of intra-European approaches (in the regular ERANET scheme, see below) and in terms of coordination of a group of European countries. This bottom up dynamic is not at all reflected in the country strategies so far.

[22] See: http://www.dius.gov.uk/pressreleases/press-release-20070712a.htm

[23] See for instance: http://www.berr.gov.uk/files/file30063.pdf

[24] http://www.berr.gov.uk/files/file34726.pdf

[25] Created as part of the reorganization of the machinery of government following the appointment of Gordon Brown as Prime Minister of the United Kingdom. More information is available at: http://www.dius.gov.uk/

The final box describes the strategic development process of Germany, as this country has started to develop more coherent and coordinated approaches.

The strategy development process in Germany

Germany is developing an internationalisation strategy, and the process and the basic rational give some interesting lessons.

First, the *process* to design this strategy was accompanied by an **intensified discourse** of a broad range of stakeholders. For example, two major events were held in the context of the large scale study on internationalisation of German research. Because that study covered key decision makers, heads of institutions, as well as a large survey of researchers, rationale between different stakeholder groups and different levels were brought together and exchanged. Participants were individuals responsible for internationalisation strategies or at least coordination of international activities in the largest German research organisations and the Federation of Universities, the major funding organisations and foundations, the major ministries (Education and Research, Foreign Ministry, Economics) and the State.

The **evidence-based discourse** that unfolded, in two dedicated workshops and in subsequent presentations and exchanges, led to more transparency and to a clearer understanding about the actor specific motivations, hindrances, long term strategic intentions, good practice and indeed potential synergies. This was not a discourse on thematic priorities, rather a **discourse on framework conditions**, **benefit expectations, and bottlenecks and good practice** in order to find ways in which policy and heads of research and funding organisations can play together for the common benefit. One should not assume that this process has improved the situation entirely and immediately, but it appears as one part of a broader discursive strategy and as a personal assessment of someone who has been involved – the exchange has had its effect on the actors involved in terms of eye opening for the contexts and activities of other stakeholders.

Subsequently, the BMBF plans to install **a new inter-administrative, open committee on internationalisation**. This will be composed of representatives of major ministries, supporting agencies, the large research and funding organisations, and representatives of the business environment organisations. In contrast to the existing committee of research, funding organisations and the ministry that regularly meets to discuss general strategic issues, this committee will **exclusively** deal with issues of **international** research and mobility. Furthermore, in contrast to the GSIF of the UK, the principle idea is that the BMBF shall be a **strong process leader** in this. The committee is not meant to be a forum for exchange only, but also prepare concrete policy action. Therefore, it shall **combine forum and advisory function**, and give the ministry more leverage and legitimacy for dedicated action. Furthermore, the committee will go on in asking for and providing strategic intelligence, both in terms of ex ante analysis for priority setting and ex post analysis of effectiveness of measures. However, a third principle will be to **integrate strategic intelligence quickly** and confront stakeholder with evidence that is collected as quickly as possible. It is the idea of combining 'quick' evidence and stakeholder discourse (informed stakeholder discourse) rather than designing strategic intelligence tools that are overly sophisticated, timely and somewhat aloof from stakeholder realities. In a simple interpretation, the idea is to find a **middle ground between consensus by discourse and decision by intelligence**.

Finally, as part of this broader and more conscious discourse, the BMBF has started to become more **pro-active in international fora** on the issue of internationalisation. Two recent examples may suffice: the BMBF had the in the CREST working group on internationalisation, and the BMBF actively supported the OECD study on the Chinese innovation system, especially the parts on internationalisation and SWOT analysis. The idea is to gather information and learn from abroad, but also to signal international responsibility and actor capacity for future cooperation to come.

In a personal assessment and based on broad anecdotal evidence and involvement in two recent studies for the ministry, the combination of various studies, new support activities, and the broadening of international opportunities inward and outward is bearing fruits. German actors across the board are much

more aware of the opportunities of international activities; a 'discourse of pitfalls' has turned into a 'discourse of chance' – even if not fully uncontested. This discourse has a focus on public research, but increasingly the BMBF is engaged in strategic discussions with foreign companies, to provide for tailored support and to maximise mutual benefits for the companies and the German innovation system.

The lesson here is crucial: any strategic action in terms of public support of international activities in science and technologies needs to be transparent and explicit about the various perspectives and rationales, not only in terms of the scientific community, but also in terms of administrations and ministries.

3.3 Science and Technology Agreements

All countries have manifold mainly bi-lateral Science and Technology Agreements. There is a new movement towards using them more strategically, both in terms of country focus and in terms of integrating the opportunities opened up with other countries into national thematic strategies. Concrete examples (Germany, Austria and the UK-India agreement) show what a more strategic use of STI agreements might look like.

The following boxes summarise

(1) the attempt of Austria to make more strategic sense and use of their STI agreements, a combination of good strategic practice and lessons stemming form evaluation activity.

(2) the new generation of STI agreements in Germany

(3) the UK-India Education and Research Initiative, a new style of large-scale bilateral agreement built by close collaboration between a number of UK government departments and agencies together with private sector sponsorship

Example 1: Scientific-technological agreements in Austria – achievements and evaluation activity

The so called Wissenschaftlich-Technologische Zusammearbeit (WTZ), scientific-technological cooperation, in Austria is based on bi-lateral agreements. These agreements mainly provide for mobility opportunities, both inward and outward. They are seen as the first and major step to internationalise the Austrian science system.

Their major principle is **reciprocity**, i.e. each partner country pays for his or her scientists. According to interviews and an evaluation, these agreements indeed live, and their effects on mobility and on triggering further cooperation appear to be fair. Currently, 14 of these agreements are active, which indicates a selective rather than a broad approach.[26] Internally, the agreements are administered and managed through **one central office**, rather than being scattered according to different country responsibilities.

The ministry for science and research in principle tries to fill these agreements through **a proactive and integrative definition of subject area** ones the agreements have been set up. The scientific areas are defined through **committees of policy makers *and* scientists from Austria and from the partner**

[26] The agreements are active with China, France, UK, Italy, Croatia, Poland, Russia, Slovenia, Spain, Czech Republic, Spain, Ukraine, Hungary, Slovenia, and not active with Israel, Bulgaria,, Rumania are not active according to the evaluation report 2004, op. cit..

countries, mostly, however, ex post, i.e. ***after*** the agreement has been signed. However, the evaluation reveals that most of the co-operations focus on natural sciences and engineering, as most partner countries have their focus in these areas in terms of international cooperation.

In order to improve the performance of this program and test its effectiveness, the responsible ministry has carried out an **evaluation**.[27] Indeed, it appears to be the first full scale evaluation with some of this programmes running for more than 20 years. The evaluation activity is part of plans to improve the Austrian funding system as such, fitting into a whole range of recent or planned evaluation activities in the country in general.

The evaluation report covers 12 agreements (now 14). The evaluation listed the number of projects and budgets spent. This was facilitated through the **centralised administration** of the programmes and thus **a simple data monitoring**. On average, between 1997 and 2003 26 projects (meaning: mobility in on-going or future co-operations) per country have been financed. For the 12 agreements, between 228 (1997) and 348 (2003) co-operations have been supported. Each project received travel funds of roughly 1500 EURO to 1900 Euro (annual averages per project). Per annum, the 12 agreements covered spent between 338 000 EURO (1997) and 672 000 EURO (maximum, 2003).

The evaluation further conducted a **large scale survey** on 600 individuals and institutions receiving grants (response: 371, 62%). 86% of the participants came from Universities. The evaluation reveals a set of important lessons for STI agreements and mobility schemes:

1) participation is facilitated through highly **un-bureaucratic** administration and a relatively high success rate.
2) **Quality control** at the outset is crucial, both for the success and for the contribution of the programme to Austria policy goals. However, there is a **link to national priorities**, as each project is evaluated not only in terms of its scientific value, feasibility and appropriateness of the proposer, but also in terms of the fit to the Austrian priorities within this programme (check for 'national interest'). Recently, the evaluation criteria have been expanded to **include the potential for subsequent research co-operations** and **the mobilisation of young researchers** (up to the age of 35).

The program appears to be **successful**. Success of the programme is measured in terms of achievements of scientific aims (90%,), preparation of further international scientific co-operations (35%), initiating first time contacts to international institutions (42%), and, last but not least, international co-publications (75%).

Improvements demanded by respondents comprise mainly concrete services such as direct support with visa, information on running bi- and multi-lateral projects with the partner countries, information on additional funding possibilities, and transparency in terms of funding decisions. However, two thirds of the participants reported no problems whatsoever.

Overall, the STI agreements have **triggering, catalysing effect**, which is now expanded as more and more young scientists are supposed to participate. Further, the systematic, if somewhat simple, evaluation has contributed to drawing the lesson to invest further in mobility and in the establishment of un-bureaucratic measures to involve young scientists in international co-operations, laying the grounds for long-term orientation towards international cooperation. The programmes are not tight to national thematic programmes, but rather define their content on a country-by-country basis, linking overall priorities to the potential and interest of the partner countries.

A for **future developments**, with the advent of ERANET, there are discussions underway to merge individual agreements with on-going ERANETS, providing for targeted multilateral cooperation opportunities. The Austrian government had these agreement evaluated. Some features of the agreement

[27] Evaluation report: Buzeczki, C. (2004): Wissenschaftlich-technische Zusammenarbeit / WTZ, October (manuscript),

appear to be good practice (though by far not all of them). In that sense, the STI agreements have prepared the grounds for co-operation of programmes. However, the challenge – yet unresolved – is the transition from bi-lateral schemes to multi-lateral coordination. Broader cooperation potential would have to be weighed against more bureaucracy and less tailored prioritisation.

Example 2: Germany: New generation of bi-lateral STI agreements

In a new approach to STI agreements, currently developed for Egypt, South Africa and India, diplomatic interests is **combined with scientific prioritisation**, which is **guided by a national High Tech strategy**. The programmes seek to **create new, sustainable structures** that will carry on with the involvement of the scientific community from both sides and in doing so **switch the mode** of international cooperation from small scale, scattered projects **to strategically focused, more large scale** co-operations.[28]

The starting point has been a scientific-diplomatic approach by the science minister to forge better links with India in the context of the so-called High Tech strategy which has defined a range of focus areas (future markets) in which stronger links are needed. The idea is to combine funds from two countries into a new, bilateral funding organisation. Thus, there will not be a common German-Indian science centre, but a common German-Indian science funding centre located both in New Delhi and Bonn. The centre will be governed through a German-Indian board and administered with the help of German administrators in India.

The technological and scientific priority areas for the funding will be directly linked to the priority areas of the *National* High Tech Strategy, thus strategically integrated. Through consultation with the scientific community cooperating or seeking to cooperate with Indian partners the priority areas may be fine-tuned, but the overall areas are given. The German priorities are then matched with the strengths of India, the knowledge about which is gathered through the embassies, business federations, experts active in India etc.. The focus is on scientific-technological clusters in India, the funded programme should benefit from existing critical mass rather than establishing new lines of activity. Ideally, the scientific interest is matched with existing economic ties of German actors, combining scientific and economic interest. Funding jointly German-Indian research projects that fit both the regional focus and the catalogue of priority areas of the National High Tech Strategy thus is regarded as a means to fulfil these aims simultaneously.[29] This approach is a sign of the new more coherent strategy to align international funding activities with national priorities.

A further requirement for the priority setting is that India must have matching funding programmes. In areas in which India does not have those funding programmes, no funds will be provided. This is a consequence out of past experience, as often collaborative programmes could not succeed because the matching funds in partner countries had not been provided. Within the areas that have sufficient overlap with German and Indian interests (documented through dedicated funds in both national systems) the projects to be funded will be much larger and strategic than bi-lateral projects in the past, traditional model. In a first phase of the program each country provides 4 Mio EURO for the funding centre.

[28] Besides, it seems that the preparation phase for Egypt and South Africa programmes did still follow a scientific-diplomatic imperative, thus was not as systematically integrated into the High Tech strategy and new focus on clearly defined scientific interest as the Indian case, which is regarded as pilot model for the new approach.

[29] This again is to be seen in a larger context of German-Indian economic cooperation (including a German Indian Business Centre) that cannot be dealt with in detail here.

UK-India Education and Research Initiative (UKIERI)

This major new bilateral initiative aims to substantially improve research and education links between India and the UK, and is notable for the inter-agency/ministry collaboration involved in setting it up (on the UK side).

The three main strands of the initiative are:

- Higher Education and Research
- Schools; and
- Professional and Technical Skills.

The Initiative also presents an opportunity for high level dialogue between the two countries on areas of mutual policy interest such as quality assurance, international standards and credit recognition schemes.

Under the initiative, the United Kingdom has pledged £12 million through contributions by various Government departments and by the independent British Council. Furthermore, the private sector has added £4 million through the 4 'corporate champions' BAE, BP, GSK and Shell to this fund. The Department of Science and Technology of the Government of India has pledged matching funding for science related collaboration under the initiative. The ultimate aim of the programme is to "create a 'step change' in educational relations between India and the UK over the next five years, so that in the longer term the two countries become each other's partner of choice in education".

The largest part of the £12 million UK government funding will be directed towards **Research and Higher Education** collaborations, with an emphasis on promoting the formation of durable institution-to-institution links. The two principal activities will be promoting research partnerships between centres of excellence, and developing joint and dual course delivery. Project proposals are evaluated according to research merit, potential for innovation and overall benefit, with subject areas drawn from science and technology, the social sciences and other areas of economic importance in the India-UK relationship. Funding will support staff and student exchanges, promoting new links between HEIs and research centres of excellence. Research cooperation projects might include staff secondments, exchanges of postdoctoral and other research workers and support for postgraduate research students in both UK and India. Collaborative delivery projects will include taught Master's courses (Full Awards), and shorter postgraduate professional courses (Short Awards). Collaborative delivery projects will normally receive support for a 3 year start-up period.

UKIERI have set a number of 'minimum targets' to be met by 2011:

- 50 new collaborative research projects, including 5 'major' projects linking centres of excellence
- 40 new UK award programmes delivered collaboratively in India with 2,000 Indian students enrolled
- 300 additional Indian research students, postdoctoral researchers and staff will have worked in the UK
- 200 UK researchers worked in India and 200 UK undergraduate students supported for studies in India
- 2000 Indian research students completed research degrees in the UK through collaborative delivery

UKIERI is felt by its UK Government sponsors to be an example of a new kind of initiative made possible by the collaborative approach of the recently-established Global Science and Innovation Forum (GSIF).

3.4 International Organisations

The current strategies of the countries surveyed do not cover in detail the rationales in terms of membership in International Organisations. In fact it appears that in terms of future oriented decision-making, international facilities and organisations are not of high importance anymore, as the countries appear to be well settled here. For some countries, e.g. Switzerland, Austria, Netherlands the issue is to justify existing memberships and to rationalise the net value of the membership. The major criterion used is the potential long-term usage by and spill over for domestic scientists, the training potential and the economic returns. Most of the countries rely on stakeholder discourse to verify the net value and the pay off in the long-run. Major exceptions are Austria and Switzerland. The following boxes highlight these two approaches, which are rather similar. As the Austrian approach is more sophisticated and more general, it will be described in greater detail, while the Swiss approach can be shortly summarised.

Example 1: The Swiss evaluation of benefits from membership in International Organisations

In Switzerland, the membership in international organisations such as CERN or the European Space Agency have a very high priority. As the relative budget for these memberships is large, the Swiss government has regular evaluations done for those memberships[30]. These evaluations try to measure

- the **actual usage** of the facilities,
- the **scientific outcome** for the Swiss scientific community (publications),
- governance: the **way the scientists are integrated into the governance** and decision making in the facility,
- the **educational effects** for young scientists (learning, exchange),
- the **effects on industry** (measures as Industry Return Coefficient and as beam time usage and output). The Industrial Return Coefficient is a simple measure relating the share of supply to the ESFR by Swiss industry (through procurement) to the share of membership fee Switzerland is paying.
- and the **opportunity costs** (value of alternative spending of the money).

While this exercise has its methodological limits it nevertheless provides arguments for or against continuation or better usage of the international facility. The evaluations for membership in International Organisations are done every four years in Switzerland. This **keeps up the performance pressure** and **gives a sound basis** for the decision to continue membership. Up to now, no major revision of membership has been done based on these evaluations.

Example 2: Evaluation of membership in International Organisations – the example of Austria

The membership in International Organisations is hotly debated – or was hotly debated in the past – especially in small countries. Membership fees amount to a large share of dedicated thematic country budgets, and effects and appropriateness of memberships for the national context and science community are hard to assess. For that reason, some countries assess the effectiveness and efficiency of membership. These attempts cannot claim to result in a clear quantitative results, indicating a monetary leverage effect. The examples of Austria provides some lessons how to conduct such evaluation – albeit we cannot claim to judge the methodological approaches in great detail here. The evaluation is done for existing memberships, but with the purpose to derive lessons and decision criteria for the potential membership in ESO. In Austria, the concrete reason to conduct an evaluation has been to assess if a membership in the European Space Observatory would be efficient and desirable for the country.

[30] See as one example the evaluation of the European Synchrotron Radiation Facility in Grenoble, available at: http://www.sbf.admin.ch/htm/dokumentation/publikationen/forschung/ESRF-web.pdf

The **starting point** for the assessment was the **description of scientific mega-trends**, in order to assess the strategic fit of the organisations for the future, their centrality in terms of important scientific developments to come. Then, for each existing membership a **uniform** description and analysis was conducted. This included a **description** of each organisation following **11 descriptive uniform criteria**: breadth of topics covered, basic/application oriented research, theoretical orientation, spin off potential, position of the facility within the scientific discipline in general (leading edge?), integration into the international community (centrality), service character (providing necessary equipment), potential for further training, independence of the research programme, relevance of the results for society.

On that basis, the assessment **analysed the Austrian participation.** This took into account

- the annual membership fees
- the development of Austrian contribution to the standard and the elective programme of the organisation over the last 5 years,
- the share of employees at the organisation and - the membership in steering bodies of the organisation,
- the direct economic effect in terms of relative shares of industry contracts from ESA (compared to the share of financial contribution, the overall expenses of the country in the respective scientific area and the development of the turnover in Austria in the area as such[31])

To support the **concrete** membership **decision** for ESO, the same descriptions and calculations and considerations are done for ESO with its active member states. Subsequently, following aspects are discussed in detail:

- **costs**: fee and one-time investment fee
- **scientific merit**: scientific capacity to profit, fit to national priority (e.g. space is not a priority, but spin off to other areas are to be expected, and education and international cooperation of young scientists)
- **scientific costs of non-membership**: costs of alternative infrastructure, access to infrastructure and database for non-members (ESO: exclusion from scientific database for non-members), costs of alternatives, if any are available, consequences for recruiting international stars in the field=
- **economic aspects**: expectations of direct and indirect benefit, especially in terms of spill over to complementary technologies, with a listing of potential beneficiaries
- **management aspects**: could Austria influence decisions (in case of ESO: no), and what support structures are needed (information office)
- **societal aspects**: ESO membership to boost attractiveness of scientific-technological education in Austria (which is low)
- **foreign policy** aspects: what signals have been sent in the past, how will a decision be assessed elsewhere, what does hesitation mean in terms of alternative international activities?

The evaluation then **maps** a) the **thematic areas** of the **organisations** to a) the scientific **megatrends** and b) to the **national priorities**, finding a strong position of ESO in this triangular relationship. Further, the share of membership fees out of public R&D spending is compared to other countries, with Austria spending relatively less.

Subsequently, a **cost-benefit calculations** for the existing membership are conducted, comparing the share of contributions and the share of benefit variables (contracts, employees, human resource, usage of

[31] To illustrate these measures for one organisation, for *ESA* the share of industrial contracts for Austria is 0.89%, the share of the budget to the standard program of ESA is 2.5%, to the elective program it is 0.96, concluding that in comparison to other countries, the direct economic benefit is lower. Further, the value of the direct industrial contracts to Austria was 75% of the overall public expenditure in space technologies, in other countries on average this ratio was 150%, concluding that Austria in terms of economic benefit does not do as well as other countries. Finally, the turnover in the space industry has growrn much stronger than the contracts out of ESA for Austria.

equipment etc.). These considerations are done, as far as possible, over time in order to assess typical developments.

On the basis of these variables, **success factors** for membership are calculated (regression model), asking what influenced the relation of costs (fees) to positive effects (usage, employees, contracts, number of trained personnel). The results are differentiated for the major dimensions of participations. The following 'success' factors have been identified:

- Human resource: a high concordance with national research priorities, low scientific standing of Austrian scientists[32],
- Scientific benefit: high foreign policy relevance, duration of membership (effect takes time)
- Economic benefit: no clear assessment possible

Finally, the international organisations in which Austria is member are clustered according to the descriptive variables (see above). On that basis the assessors derive that ESO has a high resemblance to those organisations (mainly ESA and CERN) in which Austria has been overly successful in the last years, especially in terms of Human Resource.

The assessment concludes with concrete recommendations for each international organisation, based on the development of megatrends, the Austrian relative benefit, the Austrian scientific priorities and the European framework conditions. In terms of ESO, the recommendation is that if the country does not want to let its space research and technologies dry out, membership would be crucial and cost-efficient. However, it should be linked to a structural development plan for the scientific area and related industry in Austria as such.

A final box outlines the UK approach, in which international collaboration around international research organisations is very much considered in the context of planning domestic research and infrastructure priorities (as is also the case in several other European Union member states).

Example 3: UK planning for international memberships

The development of a long-term planning process for infrastructure needs of UK science has helped identify the UK's priorities for international infrastructure projects. The resulting Large Facilities Roadmap is periodically updated in consultation with the scientific community. Working together, the UK Research Councils are responsible for producing the **Large Facilities Roadmap**[33]. This Roadmap provides UK policy makers and researchers with a clear, strategic view of how best to provide scientists access to world class research facilities and also how best to manage the investment of public funds in such facilities. Covering all academic disciplines funded by the Research Councils, including social sciences and humanities, the Roadmap provides a comprehensive picture of the new facilities which are already under construction in the UK, and provides details of potential large facility and infrastructure projects that the Government and the UK's Research Councils would like to see available to researchers over the next 10-15 years. The Roadmap also provides a basis for discussions with international partners about future investments.

The Roadmap is not a formal prioritisation for spending purposes – there is a parallel exercise conducted for access to large capital funding which draws upon the Roadmap. Rather it presents an agreed statement of likely future needs and how these can be met. The roadmapping process starts from the recognition that

[32] Indeed, in areas in which Austrian scientists are very strong in international comparison, their success in trems of Human Resource in international organisations is comparatively low. .Membership is thus a means to catch up in terms of Human Resource, not to place world class scientists.

[33] http://www.rcuk.ac.uk/research/resinfra/lfroadmap.htm

each need can in principle be met in one of three ways: as a national (UK) facility; jointly with European partners, either in the UK or elsewhere; or jointly with other global partners (such as the United States), either in the UK or elsewhere. Planned developments already present in the European level (ESFRI) Roadmap are considered in the UK Roadmap for the extent to which they might meet the needs of the UK research community. Crucially, because prioritisation over needs and likely projects which would meet those needs within a relatively fixed science budget envelope is conducted within (and then between) the research councils, rather than a higher political level, a real debate about the 'opportunity costs' to funding for other fields of research of investing in a large national or international facility or membership is forced on the scientific community clamouring for such facilities or memberships. Most recently the UK has reorganized responsibility for large infrastructure intensive science through the creation of a single **Science and Technology Facilities Research Council**[34]. The council brings together responsibility for the operation of all UK-based large-scale research facilities (formerly managed through the Council for the Central Laboratory of the Research Councils and the management of memberships of international research facilities and projects formerly vested in individual research councils. The decision to consolidate both activities in a single facilities council was probably at least partly driven by the need to protect core research council budgets from variations in international subscription costs from unpredictable exchange rate movements.

3.5 Foreign presence and monitoring

Given the limited resources in every country and the spread of important scientific activity around the globe, monitoring scientific developments and the related policy and support should be of utmost importance for the ministries responsible for science and research. However, the systematic efforts to monitor on an international scale are limited, both in terms of money spent and in terms of countries covered.

All countries have scientific monitoring through embassies in countries of major importance. This however, appears to be of limited scope and thus as far as can be judged without sound evaluation and on the bais of the combined experience of the studying team, the value for the scientists actually active within these countries or seeking cooperation with or input from these countries is limited in most cases. The number of staff within the embassies to monitor scientific development is very limited and in general not able to grasp dynamics and activities across all major scientific fields. The reporting to the home country and the spread of these reports appears limited as well. Increasingly, the monitoring and networking is done by large research organisations or networks of Universities themselves. For example, the German Fraunhofer Society and the Max Planck Society have their own labs or offices in major countries (hubs) and have designated staff in the headquarters to monitor all major regions on the globe.

However, there are country differences, and certainly the UK activities are broader than, e.g. the German activities. The only fully-fledged monitoring and networking service among the countries surveyed is provided by the UK. The Global Watch[35] service is geared towards firms rather than public scientists. It helps companies to find state of the art technology as well as complementary partner for innovation worldwide (Knowledge Transfer Networks). The monitoring is linked to UK trade and Investment activities and international R&D cooperation grants. Denmark provides an interesting case of an attempt to build upon existing networks of representation and monitoring and go beyond the traditional services offered by these services (see box).

[34] http://www.scitech.ac.uk/

[35] http://www.dti.gov.uk/innovation/globalwatch/index.html

Innovation Centres Denmark

A completely new type of organisation which brings together the previous relevant activities of the Minstries of Foreign Affairs and of Science, Technology and Development. The first centre has opened in Silicon Valley, California[36] and the second in Shanghai[37]. A third is planned to open in Munich shortly. Each center is technically a Danish foreign mission, but the staff are not all foreign ministry diplomats. Each centre has its own profile and brings together various promotion and internationalisation activities and personnel under a single roof. The trade promotion activity of the Invest in Denmark network (Danish Trade Council) has also been brought into the Innovation Centre Denmark model. Most interestingly, a specific recommendation of the Globalisation Council was that Danish representations abroad offer 'incubation' services for Danish firms seeking to start doing business in that country, and the Innovation Centre model includes this incubation service. Other services offered to Danish business are more traditional 'innovation watch' and 'match-making' ones. The precise mix of services on offer is specific to each centre: for instance the Silicon Valley sector focuses on specific sectors, namely ICT, Life Sciences and Renewable Energy. The plan is to open at least 8 such centres in total. The choice of location of the Innovation Centres was achieved through assessment of Denmark's innovation environments in terms of strengths and weaknesses.

3.6 The meaning of Europe

It is self-evident that the most important single programme for international cooperation in all countries is the Framework Programme of the EU. All strategic documents and assessments stress the strategic value of the FP and focus their international activities towards it. Especially the smaller countries in fact align their domestic thematic priorities to the thematic areas of the FP. Up to three or four years ago, the Framework Programme and – to a much more limited extent – the EUREKA (application oriented R&D collaboration) and COST (basic and strategic science) schemes have been the only means of intra-European collaboration. In fact, most countries have limited their strategic activities within Europe to these three instruments (and large scale facilities). Bi- or multi-lateral strategies within Europe are the exception. These exceptions include multi-lateral schemes of Research Council / basic funding organisations such as the D-A-CH agreement between German, Swiss and Austrian funding organisation for basic science which on a basis of reciprocity have agreed to allow scientists funded within their schemes to change residency and take the national funds with them.

However, with the advent of the ERANET scheme this limitation to the broad, encompassing framework programme might be overcome. Programme owners and managers of all six sample countries are highly involved in this scheme for 'variable geometry' in Europe that has led to numerous joint calls and will continue to do so.[38] Interestingly, despite the enormous success of the ERANET scheme in terms of bottom up mobilisation, there are no coherent strategies to take advantage of these schemes and integrate them into broader internationalisation strategies.

It appears that after the "shock-wave" of the bottom up mobilisation all responsible ministries seek to make more systematic usage of this new instrument, linking ERANET more closely to national priorities and using them for strategic, variable country foci. One country – Austria – has started systematic activities on taking stock of ERANETS and National participation in order to align these activities with

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36 English language website: http://www.siliconvalley.um.dk/

37 English language website: http://www.shanghai.um.dk/en/Frontpage.htm

38 See the latest survey done by DG Research (DG Research 2007), available at: ftp://ftp.cordis.europa.eu/pub/coordination/docs/survey_results_en.pdf

own strategic priorities. It is not possible to judge how these catalogues of criteria and checklist for decision-making are finally applied. In any case, the Austrian example shows how systematic administrations can approach the complex decision making process and complement the bottom up dynamic of ERANET with strategic considerations (see box).

And Finland reportedly takes a more systematic approach, with intensive involvements in areas of strategic importance. On the contrary, Switzerland, albeit actively participating in some 17 ERANET, does not regard the ERANET as an overly important means for coordination of national policies, mainly because of the added bureaucracy. [39]

Making sense of ERANET – development of decision criteria in Austria

The Austrian government has commissioned two studies regarding ERANET. One study has been conducted at a rather early stage (Warta/Schibany 2006), but already after the bottom up dynamic had started. It has taken stock of the ERANET involvements of the country so far and provided an overview of involvement according to thematic areas and to ministerial institutional responsibility. Further, it attributed four purpose categories to all Austrian ERANET (learning, joint calls, research platforms (to complement industrial platforms) and umbrella function). On that basis, it gave a purely qualitative assessment of the achievements of the ERANETs and, more importantly, it developed criteria for further engagement. These criteria comprise

(1) Clear need and benefits for the funding recipients, the scientists, in terms of access to excellence and complementary expertise or the possibility to influence the international developments (e.g. in terms of standards etc.)

(2) Position of the Austrian funding programme: ability to influence joint activities, reciprocal and sustainable financing (clear commitment of all partners), and efficient implementation

(3) The position of the ERANET vis-à-vis existing international activities (does it fill a gap or is it redundant, can existing mechanisms be used for the same objectives etc.)

The result of the study have been taken into account by the ministries responsible for the programmes that are coordinated within ERANET, and it has led to a better understanding also of the potential pitfalls of this scheme. Subsequently, a second study was commissioned (Whitlegg/Traunfellner 2007) to clarify even more the conditions under which Austria should participate, based on first experiences, and to develop guidance as to the support of ERANET participants and their integration into national policy-making. The study developed criteria for development and assessment and applied them to 4 existing ERANET. One result of the study was learning: the various ministries have entirely different perceptions of what ERANET should and could do and how they should be governed[40]. The decision 'criteria' are not meant to be strict scoring variables to be applied in a mechanistic way. Rather, they comprise of a systematic checklist for the Ministry to ask, and for the ERANET to answer ex ante and during the process. The catalogue of questions comprises

(1) benefit for the RTI policy in Austria (thematic interest and fit, concrete benefits for the programme)

(2) benefit for the RTI community in Austria (enough critical mass to benefit, concrete actions to be expected of value to the community, outweighing of potential negative effects)

(3) meaning of the ERANET for the Ministry as organisation (compatible partners, similar programmes; learning effects, further development of policies in the future).

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[39] Evidence from interviews within the Commission indicates that Finland has a selective but intensive usage of the ERANET, indicating a conscious and systematic usage. However, for this report an explicit strategy to do has not been found.

[40] This is based on anecdotal evidence and on a personal discussion with a (former) Austrian policy-maker.

Finally, the two largest programme funding agencies (FFG and FWF) both had already developed an internal guideline for ERANET participation. The most detailed and operative one is from the basic science foundation FWF, which developed a list of 8 explicit criteria that all are weighted in a scale from 1 to 5. These criteria are (in brackets the weighing factor):

- strength of Austria in the area (5),
- need for international activity (1),
- experience of the consortium (2),
- composition of the consortium (participation of big players in the field (3),
- concrete objectives that fit the organisation (4),
- meaning of the ERA-NET also for the Commission (backing, 3),
- meaning for the funding organisation itself (profiling, development, international visibility etc., 5),
- further partner in Austria interested (2).

3.7 Priority setting: countries

A key to strategy is to set priorities. All of the countries surveyed place some importance in priorities in terms of countries; in fact, the strategies are often most explicit here. At the same time, the countries follow different pathways in terms of bi-lateral agreements. While Germany has an enormous range of official bi-lateral scientific and technological agreements, both at the Federal level and at the level of large research organisations, Finland or Austria are much more limited. Here, country foci are implemented via specific, flexible programme arrangements and support structures rather than government-to-government bi-lateral agreements.

There is a very obvious turn to the East, with China, India, South Korea being directions of hope and expectations. Further, but to a lesser extent, Brazil (environmental issues) and Russia play some dominant role. In contrast, the increasing investments in the Arabic world are not yet reflected in the strategy documents. As said above, there are no major attempts to priorities countries within the EU, not even in terms of focussing ERANET activities. Within the EU, country priorities are set at the level of individual programmes rather than top down.

Strikingly, the links to the largest scientific power in the world, the US, do *not* seem to be of major *strategic concern*. The reason is not that the country is neglected, rather the linkage to the US appear to be well established: the US as a location of emigration or at least part time foreign research is most attractive. However, this might be a false conclusion, as some evidence (e.g. Edler et al. 2007) suggests that the strategies in European countries have a serious gap, which is the lack of opportunities for funding of bilateral cooperation with the US.

Again, as with other strategic activities, in some countries the strong research organisations (e.g. Netherlands (TNO), Switzerland (large Universities), Germany (Fraunhofer, Max-Planck), Finland (VTT)) have their own priority countries. The activities there (offices, active marketing, collaborative centres, etc.) do not seem to be integrated into the overall country strategies, but add enormously to the variety of opportunities for bottom up and tailored cooperation.

The decision-making on priority countries is very different in the countries surveyed. In general, the country priorities follow the overall trends within Europe. Beyond this bandwagon effect, the decision making is by and large not based on strategic intelligence in terms of country profiles and a systematic mapping of scientific and technological needs and opportunities. Rather, country priorities are often rationalised ex post, especially if they are initiated by foreign ministries or Heads of States. The strategic development is based on discourse with stakeholders, with ministries trying to align their own priorities

with those of major stakeholder groupings. The main criteria here are scientific potential in terms of complementarities and cooperation. In recent years, some countries have initiated schemes that try to build up scientific and supporting administrative structures in order to build up future options for co-operations in countries that are not yet major cooperation partners.

An example of strategic priority setting in terms of countries is Austria. Here, the current strategic document stipulates a multi-layer model, whereby different sets of countries are defined in terms of geography, scientific importance, and market relevance. The country deviates from the general model of priority countries as it tries to take advantage of its specific historic and geographical position, focusing especially on Central and South Eastern Europe. Here, a consequent strategy of capacity building and networking has created a strong position in terms of collaboration and opening of markets for innovations. Another example is the UK, which has begun to identify priority countries as part of its GSIF strategy development (see box above). To support the first two of the four GSIF objectives (those concerned with research and innovation excellence) GSIF has decided to focus its attention on (i) those countries with most productive and excellent science base as determined by bibliometric evidence on the total number of scientific citations and the share of scientific papers in most prestigious journals and (ii) those major emerging economies which are rapidly expanding their science base to further fuel economic growth for instance consideration student numbers overseas and absolute spend on R&D[41]. GSIF note that a number of EU countries would score highly against the above criteria but prefers to focus on the EU as a single block – recognising the increasing importance and prominence of European Community instruments in this area. Taking the EU as a single entity then, the priority targets identified by GSIF are: Australia, Canada, China, the EU, India, Japan, South Africa, Switzerland and the US. In line with the co-ordinating rather than directing function of GSIF no new mechanisms are specifically proposed to operationalise these newly identified priorities: rather, GSIF hopes that the UK Research Councils will use existing schemes, perhaps streamlined to reduce bureaucracy. The opening of overseas offices of Research Councils UK in China, the US and India (to complement the existing Brussels office) can be seen as one concrete operationalisation of this GSIF recommendation.

3.8 Priority setting: research areas

The priority setting in terms of international activities and areas on which to focus is again determined largely by the European Framework Programme. Especially smaller countries – but no only those – have aligned their overall priorities to those of the Framework Programme. Only with the ERANET have priorities now been set through a more bottom up approach, with programme managers and owners deciding the scale and scope of intra-European cooperation.

Beyond the Framework Programme, priority setting for areas of international activity is still somewhat random, sometimes ex post (making sense of bi-lateral agreements), sometimes as part of institutional strategies (where strengths are built up bottom up and later on turned into strategy). Strategic intelligence, for example through scientific-technological profiles (indicator based studies) or foresight activities are very rare. Policy-maker rely much more on the self selection and definition process of stakeholders. The premise dominates according to which "a quick discourse beats lengthy cost-benefit analyses". Often, especially in Switzerland and Austria, the decision to collaborate with countries is taken top down, and the thematic focus within the arrangement is then defined bottom up.

Within this general framework, at least three models of prioritising can be distinguished.

> *Delegation:* Switzerland, for example, delegates the concrete definition of issue areas to major institutional actors within the domestic system and with a concrete interest for collaboration. These institutions are embedded into their roof organisations who support and back the activities

[41] GSIF Strategy, p33. http://www.berr.gov.uk/files/file34726.pdf

(such as Rector's Conference, ETH-Rat[42]). Thus, bi-lateral negotiations with partner countries are supported by direct stakeholder involvement, a clear methodological and conceptual framework is missing.

Strategic discourse: The UK again has a mixed approach. The GSIF is a discourse to engage stakeholders, but it is supported by systematic studies (including indicator based work) and foresight activities and linked to Technology Watch. The idea is to de-politicise the discourse.

Centralised discourse: In contrast, Germany follows a model in which the discourse is strongly steered by the ministry in order to avoid a non-strategic proliferation of foci. The priority areas within the bi-lateral agreements that exist are largely bottom up, but strictly within the corridors defined in the central new overall strategy document, High Tech Strategy.

3.9 Evaluation

Although international collaboration is high on the political agenda, national evaluation of international activities and the role of policy therein is still very rare, both ex post and ex ante. The standard approach of evaluating international activities is periodic assessment of the benefits in participating to the Framework Programme and to EUREKA and COST. While there are a multitude of analytical activities to understand internationalisation of industrial research, policy makers have until 3-4 years ago not looked systematically at the international activities of the public research base. This is changing now, as the UK (Technopolis 2005) and Germany (Edler et al. 2007) have done large scale studies. These studies take framework conditions into consideration and are explicitly geared towards policy recommendations (ex ante evaluations). In the UK, the study has fed the GSIF discourse, while in Germany it has informed the strategy building process of the ministry and parts of the recommendations are now part of the strategic document to be issued later this year. In two countries, Switzerland and Austria, there have been systematic evaluations of the participation in international organisations (see above) which lead to reassessment, but have not yet led to a reversal of membership strategies.

In terms of the evaluation of Science and Technology Agreements, within our 6 countries only Austria seemed to have an evaluation conducted – while in other countries the available material resembles activity reports rather than evaluations. The Austrian example of evaluation has been presented in the section on STI agreements above. Further, the example on International Organisation participation as done in Switzerland and Austria are also illustrating how evaluation can contribute directly to decision making.

In addition to general evaluations or assessments, programme evaluations take the international dimension increasingly into account. This is again true for Austria, Switzerland and Germany. In the Netherlands, all programmes have to be evaluated every four years, and the results of these evaluations lead to the modification or closure of programmes. A key feature of the Finnish high-level internationalisation strategy is its emphasis on measuring the impact of internationalisation activities. "International R&D co-operation is not an end in itself; it is a key means for creating and acquiring new knowledge. Therefore, the monitoring of advances in co-operation must not be limited to input factors and their allocation between different co-operation partners and bodies or fields… The actual aim is to find out to what extent co-operation has been able to augment the knowledge stock available in Finland and to what extent it has been successfully exploited" (Internationalisation of Finnish Science and Technology (2004, p18, English summary). The strategy places the burden of developing approaches for evaluation on the major agencies, including TEKES[43]. TEKES has in fact already evaluated the extent to which its technology programmes

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42 ETH Rat is the Council of leading Universities of the country.

43 TEKES certainly considers international benchmarking in evaluating the performance of the Finnish innovation system, collecting data on other countries performance for comparison purposes (Hyvarinen and Rautiainen, 2007).

enable or encourage internationalisation (TEKES, 2004). The review compares the Finnish situation with Sweden, Germany, Switzerland, the Netherlands, Estonia and Ireland[44].The strategy states that the council will continue to follow the development of internationalisation of Finnish STI and will issue an assessment on this by the end of 2006. However no such assessment has so far been published (other than the further remarks on internationalisation in the 2006 general strategy document) and it remains unclear to what extent the 2004 strategy has impacted on the existing pattern of collaboration and internationalisation activity.

3.10 Conclusions

This report summarised trends in international research and on the strategic policy making in terms of international research activities. Given the intensified international activities of scientists in all of the countries surveyed, it is remarkable that in most of them the strategy development is still in its infancy. Moreover, it is far from clear yet if and how internationalisation strategies in S&T policy actually work. While strategies help to implement concrete internationalisation targets within programmes (legitimation) and to mobilise budget for targeted action, the complexity of the actor arena in S&T appears to be an obstacle for a clear cut strategy development, let alone implementation.

The interview partners in our survey indicated that strategy development is important to raise awareness among the community and within the administration. But they also acknowledge that in no case has a comprehensive, coordinated and concrete implementation of road maps yet taken place. Having a strategy document and implementing strategic action is not the same. The major reason appears to be the complexity and heterogeneity in the arena of S&T policy, with fragmented administrations and competing expectations in terms of priorities and impacts. *This is not to say that explicit strategies are not important, but a first lesson here is that strategy development needs to be accompanied by discourse and by an implementation plan, at the core of which stakeholder involvement, especially across administration, is the key.*

This also implies coordination of the variety of stakeholders. Here it is obvious that coordination in terms of internationalisation is limited just as overall coordination is limited, and the more general RTDI policy is coordinated, the better for international coordination. Interestingly, the need to coordinate internationally with other countries, e.g. through ERANETs, also leads to new internal coordination mechanisms.

However, at the same time trying to coordinate too strongly, too much top down, may be detrimental as obviously interests and contexts are very heterogeneous. What is good for a basic research institution might be detrimental for industry and market oriented institutes.

Regarding the legitimation for international activity and its support, all countries still rely on indirect reasoning. While there are many indications from the literature regarding the potential benefits of international activity, no cost-benefit framework exists so far regarding public support activity. The literature and country review support the premise of this study, namely that decisions, often with high and long term investments, are taken without sound strategic intelligence, without ex ante evaluation and often without a broad, transparent and participatory discourse. This is not to say that policy makers are not aware of such a need. However, costs for a sound and holistic analysis are enormous and methodological problems abundant. The last resort, it seems, are networks of stakeholders that negotiate positions to derive at a decision.

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[44] This short (one-page) review concludes that Ireland has made positive strategic attempts to boost R&D in priority areas by encouraging internationalisation and mobility, largely through SFI, but notes that this appears to have been done at the expense of driving down Framework Programme participation: "There appears to be more money available than the system can absorb" (TEKES, 2004, p25).

Indeed, a discursive approach has its merits in terms of compliance and relevance, as good policy needs to create followers to start with. Further, it is obvious that the need for international activities differs between scientific disciplines and national contexts. Given the data and framework problem, a sound, transparent, systematic discourse to define action and strategies within a defined overall policy framework for a country appears to be a sensible approach. Ideally, transparent discourse is supported by data and evidence for all claims being made by the participants. As done in Switzerland, for example, once a principal decision is made, the priority setting can be delegated to a self-organised process, supervised only by policy makers or agencies. Moreover, the decision phase should be designed in order to define criteria and benchmark for success of a measure or a membership. Thus, the ex ante evaluation done in the decision phase should lay the ground for successive interim and final evaluation. Too often, it seems, are the net-benefits of international activity taken for granted.

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Annex: Country Summaries

Foreword

This annex summarises the major findings of our country survey. These summaries focus on the major dimensions of this study, they do not – could not – claim to give a comprehensive overview of all international activities. Rather they describe the strategic considerations and institutional framework conditions in the countries, highlight a set of important individual activities, point towards specific assets and challenges, discuss the strategic intelligence for international RTDI policies and, as far as relevant point towards good practice. The aim is to understand how these countries define and implement their strategies in terms of internationalisation of science and technology.

The survey has been based on internet and document search, on a literature review[45] and on in-dept interviews with key decision makers in the countries (see below). In addition, we could take a look at the documents produced within the CREST survey activity on internationalisation of research and related policies. We are grateful to all interviewees for their openness, insights and – above all – their time, and to Marcus Breathnach, FORFAS, who has given enormous support in finding CREST and other documents and in linking us with interviewees.

Overview: The interview partners

Austria:	Mrs. A. Stoklaska, Ministry for Science and Research, Head of International Department
Finland:	Sakari Immonen, Deputy Director General, Ministry of Trade and Industry
Germany:	Joern Sonnenburg, Main Coordination of the International Office of the Federal Ministry of Education and Reserarch (also Chair of CREST Working Group)
Netherland:	Arie. C. van der Zwan, Senior Policy Advisor on International Affairs Ministry of Economic Affairs - The Netherlands
Switzerland:	Dr. P. Zinsli, Deputy Director of the State Secretariat for Education and Research
UK:	Rob Thornes, International Directorate, Office of Science and Innovation, Secretariat for GISF Global Science & Innovation Forum (GSIF)
Denmark (mini-case):	Jorn Bang Andersen, Adviser and consultant to the Danish Foreign Ministry

[45] This review included not only national sources, but also the reports and documents provided by the European service for R&D and R&D policy ERAWATCH cordis.europa.eu/erawatch as well as the service for innovation policy reviews, Trendchart, http://trendchart.cordis.lu/. These services have detailed reports on each country. Interestingly, they do not systematically cover the international dimension of national policies.

Austria

Strategic considerations

A major target of the general Austrian science and research policy is to internationalise the Austrian research landscape. However, the key context conditions that shapes internationalisation policies in S&T in Austria is the fact that responsibility for research and innovation is split between four ministries (Science/Research, Education/Culture, Economy, Innovation/Technology). In addition, a range of programme agencies is responsible for the implementation and (re-)design of programmes in the area of S&T. Further, the international co-operation in science and education is supported by the ÖAD (Austrian Exchange Service), a non-profit-making service organisation embracing general, academic and vocational education with specific focus on academic mobility. For development policy, the Austrian Development Agency runs a number of small scale programmes which are coordinated with major University actors. Finally, as in all countries surveyed, the Foreign Ministry as well as the Chancellor and Federal President from time to time take initiative in international science diplomacy. The understanding of a clear division of labour and the coordination in RTDI policies in general have been suffering from various re-organisations. Consequently, international activities in RTDI are not coordinated strategically as responsible actors would like to see it.

Currently, a strategy is being developed which is led by the ministry responsible for science and research (BMWF). It has been **supported by external consultancy** and **pushed by the Austrian Council for Research and Technology Development**, a high level, horizontal advisory committee. The major feature of the strategy is a **sophisticated shell model** of country activities. The shell model for partnership encompasses European neighbours, where Austria seeks to exploit historic ties and build up a leading position. Further, the strategy defines a limited set of activities with selected global partners, with a focus on China, Israel and Russia (common basic science programmes) and a build up of scientific monitoring and lobbying (India, Russia, China). Another element is to **take advantage (and influence) a limited set of multilateral initiatives** (mainly ERANET and a University network for Asia, see below). Finally, the country pledges to contribute to working towards the fulfilment of the global millennium goals.

The major goals of the strategy are to turn Austria into a **network node** within the larger European science space, to guarantee access of Austrian institutions and researchers to global knowledge networks, and to contribute to fulfilling global goals. Within the strategy document, **no direct link is made towards economic goals**, the strategy is entirely science (and education) policy driven.

Selected activities

As in all countries surveyed, the single most important instrument to internationalise the Austrian science system is the Framework Programme of the EU. Austria has been very successful in participating, due to a **strategy of information and networking internally** as well as the **conscious built up of strong links to the new Member States** that are now being exploited. In addition, the country has a strategy of intensive involvement in European committees and in the general international discourse.

Within the set of numerous further international activities in RTDI, a set of characteristic emerge. First, the country has only a **limited number of international agreements** (currently 14). These agreements, even if not set up in a systematic fashion and sometimes designed as instruments of diplomacy rather than science policy, **are active**. Their major activity is to **provide for international mobility**, outward and inward. They have been evaluated lately and are presented in more detail in chapter 2 of this report, to provide for lesson drawing.

The **membership in International Organisations** is a highly important issue in Austria. The country is very active in most of the important international scientific organisations, but there is an awareness of cost-efficiency and effectiveness. New entries are thus highly contested. Therefore, an evaluation has been

conducted to assess the memberships[46]. The **major criteria** for membership are **the potential participation of Austrian scientists**, and the evaluation conducted analyses the activity of Austrian scientists in great detail. The organisations are seen as major means for the **development of Human Resource** in S&T. The **basic benchmark** is if there is **enough critical mass**, now and in the future, of Austrian scientists to justify membership fees. In addition, activity within international organisations is linked with strategy development for the specific scientific area. The argument is that only through a coordinated internal effort can a small country make best use of international organisations. And **for each single membership** the **critical mass domestically** has to be ensured strategically. A short summary of the evaluation is given in the chapter 2 of the report, in the section on International Organisations.

In addition to active membership design, the country is highly active in deploying national staff, especially administrators, in international organisations to influence the international debate and link the Austrian community to it.

The national programmes in Austria are – in comparison to other EU member states – not exceptionally open to international participation. However, when designing new programmes, the international participation and outreach is of increasing importance. Some programmes now explicitly encourage participation of foreign actors, mainly under the premise of presence within Austria. Further, a small set of new programmes is much more consequent in terms of international participation (see below, good practice).

Major challenges

A major challenge for a coherent international science policy is the fact that – again as in most countries surveyed – science policy often has to follow foreign policy, i.e. to fill agreements with scientific life and purpose ex post factum. Scientists complain that their demand is not reflected in international activities at the highest level during the design of the agreements. Consequently, there is no satisfying match yet between existing country agreements and the country / thematic priorities as they are defined in the new strategy. It will be a major challenge to redesign the agreement structure in order to make best use of these agreements for the strategy. The coordination between science policy and foreign policy remains an issue, even if improvements are expected in consequence of the internationalisation strategy. Further, the dedicated budgets for international activities are not long term enough. While in principle the amount of money is not a major problem, there is a mismatch of budgeting cycles (2 years) and planning requirements, which renders international strategy and implementation challenging.

Further, even in light of the latest strategy discussion, there is no broad definition of needs and priorities. Even for science policy, the dominant rationale within the government appears to be the economic rationale, asking for the economic value or harm out of international activities. As for priority areas and priority countries, the country appears to have followed trends in the European Framework Programme for many years. The current strategy is a means to overcome this bandwagon effect.

Further, in light of the hype to open up to China, Austria has still weak links across the Atlantic. Taken the attractiveness of the US as given, too little efforts have been made in the past to establish stronger ties with the US. Up to the new strategic discussion, the bi-lateral activities have been designed by chance rather than by strategy. Lastly, a potential strength, the individual strategies of strong Universities and the multitude of individual international arrangements, has not been exploited so far (exception being the Asian University networks below).

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[46] IHS et al. (2004): Mitgliedschaft Österreichs in internationalen forschungsrelevanten Einrichtungen (Membership of Austria in international, research oriented organisations., Vienna et al. (www.rat-fte.at/files/studie_mitgliedschaften.pdf)

Major assets

Some major advantages of the country include the geographic position within Europe. With the late entry of Eastern and South-Eastern countries to the EU, Austria was able to mobilise historic ties. Through its office for the implementation and support for the Framework Programme (formerly BIT, now within FFG) numerous links were built up and the Eastern neighbours have been supported in the build up of compatible administrative structures. This now pays back through enhanced international cooperation and economic exchange.

Further, the major Universities have joined forces in their linkage with Asia. The Austrian led EURASIA PACIFIC University Net[47] , founded in 2000 – is supported mainly by the Ministry of Science and Research and by the Austrian Exchange Service (ÖAD). It manages and strives for common exchange programmes, common international proposals, conference, some individual research projects and grants (for member institutions), common curricula and even joint research centres. The network has almost 100 member institutions in Austria, China, Mongolia, Nepal, Kazakhstan, the Kyrgyz Republic, the Russian Federation, the Uzbek Republic, Bhutan, India and the Republic of Korea. This net appears to be an intelligent means to link University interest/bottom up with development of ties with Asia more generally. A similar, slightly older network was established for other parts of South East Asia (ASIA UNIET)

Strategic Intelligence

Austria has an extremely strong evaluation culture. Judged through the experience in the EU Network on Evaluation in RTD policy, it may be the strongest in Europe meanwhile.[48] The international dimension within evaluation has become much stronger in recent years, and all kinds of programmes are under pressure to justify international activities – or the lack of them.

Evaluation in the design and re-design of specific internationalisation policies has also become more important, although it is not as systematic as it should be. However, as described above, to decide on the membership to ESO, for example, a broad evaluation on the effects of the membership in other international organisations has been conducted. Further, all bi-lateral agreements have been evaluated in terms of participation, activities and individual benefit. The recommendation of this evaluation is taken into account as the new generation of agreements will be designed. Most importantly, this evaluation has looked at the sustainability, and thus the leverage of the mobility funding within these agreements.

Lastly, Austria has been the first country to engage in intelligence activity (two studies) on the pre-conditions for and merit and opportunities of ERANET[49], both of which are reported belopw (good practice).

Good Practice

Austria has been experimenting with new international approaches in recent years, indicating the need and readiness for more effective international activities, both inward and outward.

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47 http://www.eurasiapacific.net/index.php?page=content&pid=1

48 The most recent overview is provided by Platform Research and Technology Policy Evaluation / Austrian Council for Research and Technology Development (Eds.) (2007): Evaluation of Austrian Research and Technology Policies. A Summary of Austrian Evaluation Studies from 2003 to 2007, Vienna.

49 Warta, K.; Schibany, A. (2006): Perspektiven der österreichischen Beteiligung an ERA-NET, Wien. http://www.bmvit.gv.at/innovation/internationales/downloads/eranetperspektiven.pdf

For example, the Headquarter Strategy programme is designed in order to attract foreign companies to Austria. Any support provided is linked to the requirement that the company re-locates an area specific centre of competence in Austria and thus builds up competence within the country, ideally linked to hiring Austrian scientists and engineers. The major goal is the embedding of the foreign company into the Austrian knowledge networks to build up sustainable capacity and links to the global networks of that company. No evaluation is yet done for that programme, it appears that it is successful, but that the build up of domestic capacities is a major challenge.

Another programme often cited in international reviews[50] is *CIRCE* (Co-operation in Innovation and Research – Central Eastern Europe and South-Eastern Europe, http://www.ffg.at/content.php?cid=551). CIRCE supports the networking of Austrian companies and research organisations with innovative partners in Central Eastern and South Eastern Europe. It is part of the multi-layer strategy exploiting historical ties and geographical proximity. It seeks to link innovative activities (generation and application of knowledge and introduction of innovations) with market expansion an entry for Austrian firms and research institutes. It supports transnational activities such as networking, innovation (R&D, technology transfer, benchmarking, quality assurance) and mobility. The implementation I supported by existing intermediary organizations such as Competence Centres, Technology centres and clusters. There are different project types (networking, concrete innovation projects) with a public funding between 45& and 75%. The project run from 1,5 up to 3 years. The programme is radical – and even unique – in its funding approach, as up to 40% of the public contribution can be spent for the foreign partner even if this partner does not have a subsidiary within Austria.

With a similar rationale than CIRCE, i.e. to exploit knowledge and innovation capacities abroad for domestic actors, the science foundation Christian-Doppler-Gesellschaft has started to co-fund industry-University labs established jointly by Austrian companies, foreign firms and foreign Universities abroad, at the site of the foreign University. Thus, Austrian tax money is spent to build up scientific capacities abroad for the benefit of Austrian companies, but with spill over effects to a foreign science system.[51]

At a policy level, the attempt to design international activities more strategically has resulted in a first good practice case with India. Here, the agreement was in a diplomatic interest of both sides, but the science ministry has been involved from the start. Once it was apparent that the agreement would be signed, the science community was activated to help to formulate focus areas for cooperation, a small scale study was commissioned and external networks activated to give input. The same happened in India, and the scientific linkages and focus definition was thus done once the agreement was signed. After the finalisation of the treaty a mixed scientific commission defined clear priorities and an action list to start with.

Finally, Austria has started strategic planning of ERANET based on two studies. This attempt is reported in chapter 2.

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[50] See for example OPTIMAT/VDI 2005 (see references main part of the study), Gassler / Nones (2008): Internationalisation of R&D and embeddedness. The case of Austria, in: in Edler, J.; Polt, W. (ed.) (2008): International Industrial R&D – the policy challenges – special issue of Journal of Technology Transfer (forthcoming)

[51] See Edler, J. (2005): The Internationalisation of the CDG Funding Approach. Expertise within the evaluation of the Austrian CDG; Vienna / Karlsruhe

Finland

Strategic considerations

The strategic objective of internationalisation policy is to support Finland's own development and competitiveness and to respond to global problems and challenges. Finland's policy aim is of course to become a Knowledge-based Economy and this is the fundamental driver of internationalisation policy. As a small country Finland will always be highly dependent on knowledge produced elsewhere in the world. Thus the fundamental aim is to allow access to and collaboration with the leading centres for innovation, and key emerging markets, around the world[52].

Internationalisation STI policy aims are to:

- support Finland's own development and competitiveness and increased responsibility for responding to global problems and challenges
- support sustainable development of the economy and the environment, as well as romote employment, well-being, social cohesion and cultural diversity
- enhance the integration of the Finnish innovation system with international science, technology development and innovation
- combine global, European and national perspectives in a balanced manner in the development of research activities and innovation system
- promote internationalisation within Finland and participation in the different forms of international research co-operation: official and informal, multilateral and bilateral
- increase the number of high-competence jobs and the volume of research in Finland.

The high-level strategy formulated by the Science & Technology Policy Council of Finland in 2004[32] outlines these aims and objectives of internationalisation policy but also identifies the *means* or *pathways* by which these aims and objectives can be realised:

- increasing public research funding on a long term basis, continuously investing in education, and strengthening and diversifying our knowledge base and infrastructure
- alleviating the fragmentation of the research system with a view to creating and developing research units that are large enough for international co-operation
- exercising prioritisation, specialisation and selectivity at all the levels of the system, as well as strengthening the strategic decision-making and developing measures in support of these
- systematically developing an internationally competitive, high-quality knowledge base and Finland's strengths to improve the preconditions for co-operation with leading global partners
- including internationalisation-related aspects in all decision-making concerning education, science, technology and innovation

[52] See *Internationalisation of Finnish Science and Technology* (2004): http://www.minedu.fi/export/sites/default/OPM/Tiede/tiede-_ja_teknologianeuvosto/erillisraportit/liitteet/internationalisation.pdf

- promoting networking within R&D and innovation in Finland and internationally both within research fields and between them
- the government and other public sector agencies adopting a proactive role in promoting internationalisation, particularly in the preparation of measures associated with EU research and innovation policies and other international affairs
- intensifying co-operation between the public and private sectors with regard to the enhancement and utilisation of internationalisation and the strengthening of infrastructures
- improving the ability to anticipate changes and new phenomena and the opportunities opened up by these
- integrating foresight activities into decision-making and strategic steering of research and innovation policies
- removing obstacles to and restrictions in international co-operation and mobility, through amendments to legislation where necessary, and reformulating recruitment policies and developing researcher careers.

The strategy also asserts that "all organisations involved in international S&T co-operation need to have their own, comprehensive internationalisation plan" and these internationalisation strategies are made at many different levels from ministries and funding agencies, through to public sector research organisations and regional organisations and programmes. Foreign policy is no longer a major driver of internationalisation activity – the domestic innovation policy rationale is the dominant one[53]. Of course Finland is very active in EU co-operation in science, technology and innovation which of course carries an indirectly diplomatic motive. Finland tries to avoid government-to-government bilateral agreements without clear and convincing science or innovation rationales except where there is no alternative (for instance, because it is a legal requirement in the other nation). Instead the emphasis is on direct connections between research organisations or research funding organisations that have clear motives. There are no explicit criteria for prioritising individual linkage decisions – the specific agency will of course evaluate the costs and benefits of an activity but there is no set of high level strategic criteria to evaluate opportunities against, rather they are evaluated against the overall objectives of Finnish innovation policy. The high-level strategy itself makes clear that "the strategic development of internationalisation and international S&T co-operation does not require new organisations or new administrative arrangements" and that "the objectives can be achieved with the current structures through the development of collaboration and procedures". The emphasis is thus very much on co-operation amongst Finnish actors and on 'mainstreaming' the idea of internationalisation into every area of STI relevant policy: "International co-operation is not a separate function; it is an intrinsic part of Finnish research and innovation and their development. The same quality and relevance requirements apply to both domestic activities and international co-operation." (*Science, Technology, Innovation*, 2006, p19, English summary version[54]).

The size of Finland mean that co-ordination costs are arguably lower than for other countries and the Nordic consensus culture tends to ensure that once decisions have been made, actions will be implemented. Thus specific new formal co—ordination mechanisms have not been proposed in the 2004

[53] During the Cold War Finland was very aware of its border with the Soviet Union and a diplomatic imperative was to maintain and promote links in that direction.

[54] *Science, Technology, Innovation* (Science and Technology Policy Council, 2006)

Finnish strategy – rather the emphasis is on each actor improving their co-ordination with the others in the normal business of governance. Nonetheless co-ordination remains a concern to the OPM:

"At system level, the interaction of national policy advice and political decision-making will be strengthened. To this end, a new Government decree on the Science and Technology Policy Council of Finland came into force at the beginning of 2006: the term of the Council has been changed to correspond to the electoral period; the secretariat of the Council has been enforced; and key sectoral research fields will be taken into account in appointment of ministerial members to the Council. Within the Government, the Cabinet Committee on Economic Policy will handle the central issues in relation to science, technology, and innovation policy. Once every electoral period, the Government provides the Parliament with an opportunity for a comprehensive discussion bringing together these policy sectors.

The key expert organisations in the public research system in Finland are the Academy of Finland, Tekes, and Sitra (the Finnish National Fund for Research and Development). Intensification of their interaction is important, particularly with a view to enhancing the impact of research and innovation funding and creating functional entities larger than the current ones." *Science, Technology, Innovation* (Science and Technology Policy Council, 2006)

A key feature of the high-level internationalisation strategy is its emphasis on evaluation – measuring the impact of internationalisation activities. "International R&D co-operation is not an end in itself; it is a key means for creating and acquiring new knowledge. Therefore, the monitoring of advances in co-operation must not be limited to input factors and their allocation between different co-operation partners and bodies or fields… The actual aim is to find out to what extent co-operation has been able to augment the knowledge stock available in Finland and to what extent it has been successfully exploited" (*Internationalisation of Finnish Science and Technology* (2004, p18, English summary). The report goes on to note that "reliable impact assessment is difficult. In this context, units conducting S&T studies and the public expert organisations, the Academy of Finland and Tekes, have a specific development task". TEKES had in fact already evaluated the extent to which its technology programmes enable or encourage internationalisation (TEKES, 2004). The review compares the Finnish situation with Sweden, Germany, Switzerland, the Netherlands, Estonia and Ireland[55]. The OPM strategy states that the council will continue to follow the development of internationalisation of Finnish STI and will issue an assessment on this by the end of 2006. However no such assessment has so far been published (other than the further remarks on internationalisation in the 2006 general strategy document) and it is currently unclear to what extent the 2004 strategy has impacted on the existing pattern of collaboration and internationalisation activity.

Selected activities

European programmes are of course important and indeed the development of the European Research Area is acknowledged as one driver of the attempt to become more strategic with regard to internationalisation. Finland is a leading participant in FP, COST, EUREKA. The main actors active in internationalisation are the Science & Technology Policy Council of Finland (OPM - chaired by the Prime Minister)[56]; the Academy of Finland[57]; TEKES[58], the Finnish Funding Agency for Technology and

[55] The short review concludes that Ireland has made positive strategic attempts to boost R&D in priority areas by encouraging internationalisation and mobility, but notes that this appears to have been done at the expense of Framework Programme participation (TEKES, 2004, p25).

[56] OPM has as one of its explicit roles the task of "following international developments in research and technology and the development needs they cause in Finnish research and technology". See: http://www.minedu.fi/OPM/Tiede/tiede-_ja_teknologianeuvosto/?lang=en and http://www.minedu.fi/OPM/Tiede/kansainvaelinen_tiedepoliittinen_yhteistyoe/?lang=en

Innovation (the main government financing and expert organisation for research and technological development in Finland); and for enterprise internationalisation, Finnvera plc - a state owned company providing financing and export guarantees. TEKES and the Academy of Finland in particular play very active roles and are well co-ordinated in their different and complementary activities. The most recent general STI strategy document produced by the Science and Technology Policy Council in 2006, entitled *Science, Technology, Innovation*, makes clear that attempts to improve co-ordination must continue.

The current pattern of collaboration is very much the result of a mixture of strategic action and historical evolution – the accumulation of individual choices made by different actors. Now that a more formal strategy is in place there are emerging priorities around particular actions, especially in support of international collaboration in research and innovation, notably via:

- International networking of the TEKES-funded national "strategic priority centres"[59], virtual centres for science, technology and innovation in commercial or social priority fields and bringing together relevant companies, universities and research institutes. TEKES generally has the aim of promoting internationalisation activity through their mainstream funding initiative.
- Promoting the mobility of Finnish experts and researchers (there is a concern amongst Finnish policy makers that outward mobility from Finland is far too low, and discussions currently centre on how financial and professional incentives to mobility for Finnish researchers can be improved, perhaps through the manipulation of performance measures or targets).
- Conversely, attracting foreign experts to Finland (for instance through the Distinguished Professor Programme, FiDiPo, jointly managed by TEKES and the Academy[60] - see below).

Major challenges

Finland is very aware that there is increasing global competition among nations to be seen as an attractive location for business enterprises and jobs, and internationalization policy is cognizant of this. In this sense internationalization policy is a defensive stance against the risks of globalization. It is also felt that research and innovation financing must continue to be raised with a view to accelerating the internationalisation of the innovation system and to improve the overall conditions for innovation. A key priority is encouraging mobility of scientific and research staff – there is a perception that outward mobility has been comparatively low for historical and cultural reasons. Finally, it seems that there is comparatively little systematic evaluation of membership benefits of international research organisations, although Finland is a member of several of these.

Major assets

Co-ordinating the division of labour between actors and agencies in a small country is arguably somewhat less challenging than it might be in a bigger country – the division of labour (e.g. Academy of Finland

[57] http://www.aka.fi/eng/

[58] http://www.tekes.fi/eng/

[59] http://www.tekes.fi/eng/strategic_centres/

[60] http://www.tekes.fi/julkaisut/annual_review06/tekes/page56.asp

concentrates on basic research links, TEKES on applied research and innovation links) seems well-understood by all actors. Furthermore, the new strategic centres for science, technology and innovation are a major feature of Finnish innovation policy and each has an explicit international links component. In this sense the major Finnish innovation policy measure today has an explicit international dimension.

Good practice

Finland came early to high-level strategic thinking about internationalisation, helped by the existence of an unusually effective high-level council on innovation policy. A similar model may or may not be as effective in other countries which have adopted it. Apart from the overall strategic approach and the apparently good level of co-ordination between actors, it is hard to identify specific concrete examples of the operationalisation of the strategy. Rather the strategy is meant to 'mainstream' the question of internationalisation into all innovation policy initiatives. There are some emerging activities which seem to be influenced by the strategy, around internationalising the Finnish centres of excellence and around inward and outward mobility (see below for details of the Finland Distinguished Professor Programme, which brings in high-level researchers, both foreign and expatriate).

The Finland Distinguished Professor Programme

In December 2005 Finland launched The Finland Distinguished Professor Programme[61] (FiDiPro) as one measure to encourage cross border knowledge transfer and increase Finland's attractiveness for foreign investment. This is a funding programme jointly launched and co-funded by the Academy of Finland and Tekes, the Finnish Funding Agency for Technology and Innovation, to recruit foreign and expatriate professorial level top researchers to Finland for a fixed period of time.[62] The launch of this programme is based on the Government Resolution on restructuring the public finance system in April 2005.

The goal and expected impact of the funding programme is to raise the level of scientific and technological knowledge and know-how in Finland, add a more international element to the Finnish research system, generate added value into the national innovation system and support research driven profiling of universities and research institutes. The programme is also aimed at creating a new kind of international cooperation between basic and applied research and the R&D efforts of business companies. It will achieve this in part by facilitating access of skilled personnel to enterprises and trying to ensure that the future skills base meets the innovation needs of enterprises.

Within the framework of the funding programme, Finnish universities and research institutes can hire foreign researchers or professorial level Finnish researchers who permanently work abroad, for a period of two to five years to conduct research together with Finnish researchers and research groups. The researchers have to be internationally highly merited and have strong experience of researcher training. Funding from the Academy of Finland and Tekes may be applied for by Finnish universities and research institutes that submit proposals on researchers to be selected. A panel of experts evaluates the competence of the proposed candidates and the excellence of the project proposals.

The first stage of the programme is currently funding 24 research projects from an available budget of €17.5 million. This sum translates into recruiting 24 visiting top researchers to 12 Finnish universities or research institutes for 2 to 5 years. The first researchers began their work at the beginning of 2007.

[61] http://193.167.189.71/opencms/opencms/Projects/FiDiPro_en/FiDiPro.html

[62] http://www.feast.org/?opportunity&ID=511

The programme has attracted a number of eminent academics to do research in areas relevant to industry including fuzzy optimisation and fuzzy ontology, which can be employed to solve complex industrial problems and energy efficiency to achieve developments such as CO2-free production of electric energy from waste heat. The academics attracted to the scheme are being drawn from a broad international base including USA, UK, Hungary, Japan, Canada, Poland, Sweden and the Netherlands.

Although too early for any formal evaluation of the impacts of the scheme this is initially being viewed as a successful measure in Finland, in terms of establishing long-term international collaboration amongst outstanding researchers. The introduction of this scheme reflects the Finnish recognition that as a small country they are highly dependent on knowledge produced elsewhere in the world and essentially must 'buy in' international expertise, in order to complement and initiate research undertaken at home, if they are to be competitive in the global forum.

Germany

Strategic considerations

The central ministry for internationalisation of research is the Federal Ministry of Education and Research (BMBF). It is assisted by two specialised agencies, the International Office and the EU Office as operational arm of the Ministry. They support the implementation of special programmes and support activities and they contribute to the formulation of new initiatives and strategic documents. In terms of science and education policy the situation in Germany is complicated through the Federal system. The Federal Ministry is mainly responsible for large research organisations, for support programmes, and for international activities. The institutional funding of Universities and governance of Universities is done at State level. The States also have their own science and innovation policies, with very specific and heterogeneous internationalisation activities.[63]

The Federal Ministry of Economy and Technology, as second pillar for innovation policy, has no explicit internationalisation rationale or strategy. In general it has been rather sceptical, highlighting potentially detrimental effects on domestic companies stemming form international scientific activities supported by German tax money. However, this attitude has softened, and while the Ministry does not play a pro-active role in internationalisation initiatives across the board, it has incorporated schemes to support international cooperation in innovation in their programmes, most impressively in a SME scheme (Pro Inno, see below).

The foreign ministry does not play a pro-active role in shaping international science policy. It has, however, shared responsibility for the so-called scientific-technological agreements, bilateral frameworks for international scientific projects. Moreover, the Foreign Ministry in its diplomatic activities often takes the lead in setting up scientific-technological partnerships with third countries. In the past, this has not led to a coherent strategy coordinated with the BMBF. However, recently, bi-lateral agreements are dealt with more strategically and systematically, with the BMBF taking a leading role in moderating a bottom up process (see below, example of India). To complicate matters, the Ministry of the Interior is responsible for contractual conditions within the civil service, and for immigration, both key framework conditions in terms of attraction of foreign scientists and students.

Between the ministries – and indeed within the Ministries – there is no common rationale in terms of internationalisation. While horizontal departments (those for European Affairs and Internationalisation) and some thematic programmes are actively seeking to internationalise their activities, some thematic programmes remain more cautious. This more defensive rationale stems from a certain fear of a net loss out of international activities for the German innovation system, based on the size and strength of the German innovation system. However, this defensive mode is more and more on the retreat.

A very important feature of the German research system is the existence of highly autonomous large research organisations (Max-Planck-Gesellschaft, Fraunhofer Gesellschaft, Helmholtz-Gemeinschaft, Leibnitz Gemeinschaft) and one central basic science funding organisation (DFG). All of these important actors have now pro-active international activities and most of them have explicit strategic documents. The autonomy of these actors has led to different speeds and scope. But as now all of them have realised the growing importance of international activity, the autonomy also *enables tailored approaches*, with specific country and area foci that fit the specific need of their organisations. Even more, as a rule the four headquarters of research organisations try to provide supportive framework condition, but let the individual institutes proceed with their own strategies. This means, in sum, that the two-level, rather decentralised structure of German non University research institute provides for a flexible framework, in which strategic decision making is shaped from bottom up.

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63 The activities at State level cannot be covered in this report.

In terms of strategy development, the government for the first time is about to launch an official internationalisation initiative later in 2007 (cabinet level). This marks a shift as it commits all ministries to the aims drafted under the lead of the BMBF. The shift in terms of content is that there is now a very conscious and explicit link of international activity and national interest. The strategy means a break with the past and deserves a short summary – as its implicit and explicit principles are relevant beyond the German context:

- Two assumptions are rather radical given the German tradition: First, in the new document the *explicit premise* is that international activities in principle serve national aims if they serve concrete projects. As most knowledge is generated outside of Germany, the purpose is to drive administrators, researchers and firms towards much more international cooperation, In future, all national programmes shall be much more open, internationalisation is thus broadened. Second, scientific collaboration is explicitly linked to mobilizing innovation potential, the economic argument is incorporated. Thus, Germany now seeks to get more access to knowledge pools and networks, wants to show greater commitment and active planning for international organisations and be more active and visible in supporting the solution of global problems.
- Next to cooperation, a second major pillar of this strategy will be to increase the attractiveness of German research landscape, especially for scientists. To do so various activities to market German abroad will be linked ('Research in Germany', 'Invest in Germany', 'Germany, Land of Ideas'). Wherever sensible German scientific houses will be established, bringing the various different initiatives of research organisations and ministries under one roof.
- Further, the government seeks to actively support the build up of foreign subsidiaries of German research organisations (off-shore establishment), believing in the net benefit of having German public research firmly integrated into foreign knowledge networks. It is obvious that this strategy tries to link individual benefits (research income for public institutions, personal careers of researchers) with system benefits (transfer of knowledge, spill overs in the German system).
- Finally, the budget for international activities will be increased in order to establish new instruments, such as the German – Indian science Centre (see below). Even more, in line with the broadening of commitment across the administration, the financing of international activities will largely come from the existing national programmes, which will have to dedicate part of their annual budgets for international activities. Clear quantitative corridors or even objectives, however, are not given.

Priority setting: countries

In terms of country priorities, as most other countries Germany follows a shell model, i.e. a model of different country layers. In future, more focus will be put on a limited number of targeted countries. Cooperation within Europe is largely dealt with within the EU framework. In contrast to – for example – Switzerland, Germany does not develop coherent bi- or multilateral strategies with European partners. The focus of the strategy lies with countries of rising international importance: China/India/Russia/Brazil, followed by a next shell of countries for which a current diplomatic interest is more clearly linked to technological collaboration (e.g. South Africa / Egypt). The criteria for country prioritisation have shifted towards excellence, cooperation potential, interest of stakeholders and – importantly – reciprocity. This means that for the bulk of supported cooperation, in principle the partner country must provide funds (in dedicated programmes) for the local partner. Unilateral financing of the foreign partners will remain an exception and only be justified if the competence of the partner is absolutely necessary for the success of a certain project or if capacity building is in the interest of German partners in the future.

The latter must be interpreted within the context of a change in the development rationale. Moreover, in line with the principle that any international activity supported with public money must serve a clearly defined research interest of German actors, the programmes for international technological cooperation with developing countries will also be streamlined. Evaluation for projects will in future stronger check

for the concrete scientific benefit, rather than following a 'development' rationale. Where development is aimed at, in future support is likely to be given for the build up of capacities abroad that will better enable the partner countries to cooperate with German partners. Already Max-Planck Gesellschaft (large basic research institutions) and the semi-public research foundation Volkswagen-Stiftung have programmes in place to build up capacities in third countries, in light of future co-operations.

In the recent past, a *new marketing strategy* for priority countries has been developed, whereby for a selected country a range of support mechanisms to advertise German strengths and co-operation potentials have been financed. The first target country was Korea. Following some criticism by stakeholders of not having been involved in this priority setting from the outset, in future the advertising in priority countries will be coordinated more closely with the various stakeholders, including the thematic research programmes and the potential for cooperation within them.

Key selected activities

As there has been on centralised internationalisation strategy, the most important strategic activities are, as said above, done at the level of institutions. The autonomy of large research organisation has led to manifold, tailored approaches, not supervised or specifically supported by the (Federal) government. The decentralised approach is facilitated by the specific structure of having four big roof organisations playing a mediating and supporting individual institutes.

The Federal government has relied heavily on its scientific-technological-cooperation programmes, which are built upon bilateral framework agreements that then have to be filled with projects. These programmes have traditionally be a mixed blessing, as they had not been linked to country or area strategies. While many important projects have been financed, overall there is no clear evidence as to how successful the programme was in internationalising German research landscape. The activities have been too erratic, and while each project is evaluated ex ante by a commission, overall there has been no programme planning and priority setting. In addition, the partner countries sometimes could not met the requirement of reciprocity. With a new spin forbid-lateral programmes the government seeks to design a more strategic approach (see below).

The Economic Ministry has realised that participation in EU Framework Programme is not enough for German SMEs across the board to capture the opportunities and reap the benefits of cross-border innovation activities. Therefore, in the second phase of its major SME oriented programme ProInno, financing research and innovation collaborations, the Ministry for the first time introduced an incentive for international collaboration. German SME that cooperated with an international partner received a higher funding rate to make up for additional transaction and learning costs. The scheme was successful as the cooperation with international partners increased significantly in numbers. The recent evaluation of that programme differentiated the success of participation for international collaboration.[64] It asked if the incentive to facilitate international collaboration has worked (has the share of international collaboration grown?) and in how far the international projects differ in terms of their effects. In the concrete case of the Pro Inno program the international co-operations performed well as they offered the possibility to deepen existing links with foreign partners and broaden them with research and innovation activities.

One major focus of the German internationalisation activities appears to be the inward attraction of students and post docs. This is mainly provided by two foundations, with one (DAAD) taking care of general student exchange and scholarships, and one concentrating on elite scholars (AvH). This division of labour has proven successful, as it combines elite profiling and mass attraction and allows for specialist offers. One lesson of the latest study on German internationalisation has been, however, that it is overly

[64] Kulicke, M; Lo, V. (2006): Untersuchung der Wirksamkeit des Förderprogramms PRO INNO und Evaluierung des Anlaufs von PRO INNO II. Zusammenfassung der 3 Module der Programm-evaluation April 2006, http://www.forschungskoop.de/60_pdf/pi-sonstiges/pro_inno_eva-2006.pdf

important to integrate actively foreign scholars and students into the system. Especially doctoral students have not been satisfied with the scope and intensity of interaction with German scientists. Local presence is not enough, there needs to be an integration programme. In addition, the numbers attracted so far appear not to be high enough to provide for the demand of scientists in the country. Tus, the new strategy puts inward and outward mobility as one of the major aims.

A further major activity recently is the provision of support in international cooperation in terms of legal and strategic advice (see below, strategic intelligence).

The monitoring of activities outside Germany is still not systematic. It focuses on a couple of countries, compared to other countries (e.g. France, UK) the number of attachés with sound scientific understanding is limited, counselors are not integrated into the national discourse, their reports nor part of bottom up country strategy making. Within the new strategy, it is planned to combine the activities of attachés with the activities of the research and funding organisations as well as foundations, to provide coordinate collection and exchange of information that can be fed into the national system more quickly and more broadly – and more efficiently.

International facilities and their merit are *not* hotly debated in Germany. There is still a strong willingness to attract major investment in Germany and thereby to profit from spill overs in the national system. However, there is a recognition that these investments within Germany need to be assessed ex ante and on a regular basis (interim) in order to justify German payments as up to now there are no systematic evaluations. The membership of Germany in international facilities and organisations is not contested, but again, major evaluations as for the relative merit of this membership are not done. A further pillar of international ministerial activity is the firm commitment to more personal engagement. Germany is not represented in international organisations relative to the size and relative importance to the country.

The integration of Europe into the international activities is rather complex in Germany. Traditionally, there has been a divide between the administrators responsible for international cooperation (meaning extra European) and the those responsible for Europe (Framework Programme, COST; EUREKA). This meant that within Europe no major bi-or multinational activities have been launched, cooperation within Europe has been embedded into European frameworks. The new internationalisation initiative links the two dimensions closer together[65]. Even in Germany, with its large research programmes across a wide range of areas, the thematic priority areas in national programmes are aligned with the EU Framework Programme priorities. This follows an analysis (ad hoc, no systematic evaluation available) according to which success at European level increases if national programmes within the same priority lines are available. The previous UK model, to decrease the funding in areas in which the EU funds, is explicitly rejected in Germany.

Further, the ERANET development and the very strong involvement of German actors from ministries and agencies alike has taken German decision makers by surprise. However, meanwhile a systematic process to streamline the ERANET activities, to maximise benefit and to minimise efficiency losses has been started.

A second important focus are Inco Nets. Similar to ERA-Net these schemes seek to align administrations in their efforts to start variable (funding) co-operations with extra-European partners. In contrast to ERANET, these activities are bundled within one agency, the International office of the BMBF, reflecting the remit of this agency. Thus it appears that the strategies are more coherent now.

In terms of Technology Platforms, no systematic activity at policy level is underway, the platforms are monitored, links to German initiatives provided and participating actors supported if they seek advice.

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[65] This is not uncontested, as some in the Ministry argue that the integration of international and European matters deludes from the extra efforts that are needed for the extra-European dimension. This shows that the coordination of these two levels is still not fully settled in Germany.

Strategic Intelligence

Up to now the strategic intelligence in terms of international R&D activities and its support has been limited. But as stated above, in conjunction with the new strategic activities more studies are done as to the international R&D activities both of companies (Döhrn / Rothgang / Edler 2003) and of public researchers (Edler et al. 2007). For the new strategy, a set of studies were commissioned (e.g. Elder et al 2007, Frietsch et al. 2007) in order to underpin the rationale for the new internationalisation strategy. Currently a tender is pending that seeks to examine the experience of German researchers abroad and tries to understand why foreign countries seem to be more attractive for scientists than Germany.

The BMBF has further issued a study on IPR and international cooperation, mainly with Asian countries. This study is supposed to lead to support and advice programmes for different kind of actors. This accompanying activity is highly important, as currently the discourse on Chinese dangers endangers a fruitful cooperation with Chinese actors. The awareness and guidelines provided appear to be more important than just another support programme, especially as they lead to a more general acceptance of collaboration with partners from Asia.

In terms of priority setting, the BMBF had launched a promising set of studies, which however, never materialised in concrete strategic planning. The idea was to identify, through bibliometric and technometric analysis, hot spots, potential cooperation partners, in countries that are not in the focus of German researchers yet (then Brasil, Turkey, North African countries). It is not clear yet if this approach will be integrated in the new strategy, but it has the potential of supporting strategic country and area choices.

In the traditional bi-lateral agreements strategic intelligence is only provided by bi-lateral commissions, composed of administrators and scientists of the partner countries who try to define sufficient overlap of interest and complementarities of capabilities and assess concrete projects. This limited discursive approach is now slowly broadened, into a broader, more systematic discourse (see below).

Strikingly, until recently, the international dimension has not been an important issue in standard evaluation of national programmes at all. This is changing now, however. The BMBF plans to increasingly monitor programmes in terms of international participation and openness. For those few that have an explicit international dimension to them, as the SME programme ProInno (see above), this is done already.

Good Practice

a) New principles of institutionalising a strategic discourse on international science and technology

As described above, there is a clear dynamic towards a more strategic approach towards international R&D activities. This is reflected also in a new institutionalisation of a specific international discourse moderated by the BMBF. There is a clear attempt to include systematically all relevant actors in a discourse specifically on internationalisation of science and to raise awareness at all levels. This includes internal (within Germany) and external (within multilateral for a) discourse. The good practice element is still more promising than proven, but the structures and processes are there. Chapter 2 gives a description of this strategy process.

b) Country priority and challenge discourse – the case of China

The BMBF has recognised that for some areas or countries it is not only the availability of funds for cooperation that is important, but a range of issues have to be discussed systematically in order to give a sound basis for joint cooperative projects and a broadening of networks. This is especially true in regions that grow immensely and change from cheap markets into broad scientific-technological partners (and indeed competitors). One current example, that is assessed as good practice and should be a pilot for other regions in the future, is China. For China, the discourse in Germany is a very defensive one, nurtured by pretext rather than information. Therefore, the BMBF has organised one week of workshops and

discussion among major stakeholders. The workshops not only covered potential scientific and technological areas for cooperation, but also tried to bring forward a broader understanding of the country. This included a SWOT analysis of the country and of cooperation potential, legal framework conditions (IPR), support framework conditions and – most importantly – cultural characteristics. Accordingly, the participants ranged from scientists of different areas with an interest in collaborating with Chinese actors to academic China experts (from various disciplines, cultural studies, economics, etc.) and administrators and policy makers.

c) New generation of bi-lateral funding programmes

At an instrumental level, one current good practice is the design of a new generation of bi-lateral framework programmes and funding organisations. This new approach is being developed currently for Egypt, India and South Africa. The good practice – better the promising practice – of the second general agreements is described in detail in chapter 2.

Netherlands

Strategic Considerations

The Dutch research system is characterised by distributed responsibility. Different ministries are responsible for research policy in the relevant specific field. The **Ministry of Education, Culture and Science** (OCW) is responsible for coordinating National research policy, international science policy and the operation of research organisations in the Netherlands. The **Ministry of Economic Affairs** aims to promote the development and application of technological knowledge by companies and to strengthen the knowledge base through collaboration between companies and knowledge institutes.[66] A key actor in the MEA is the **Agency for International Business and Cooperation** (EVD). Its mission is to promote and encourage international business and international cooperation. The EVD is a government agency and works for various governmental authorities on projects and programmes that involve international business and international cooperation. The EVD also administers European projects on behalf of the Ministry of Economic Affairs.

The main objective of Dutch internationalisation STI policy is cooperation based on current research or innovation excellence, with a further driver being potential future markets. It is a focused approach in clearly selected priority areas. Innovation and research to meet social challenges are likely to be much more important for the new Dutch government and this new broad priority will undoubtedly affect internationalisation strategy in the future.

There are four main elements of current internationalisation activity. The most important is participation in the Framework programme of DG Research and the innovation programme of DG Enterprise. This is the core of the international and innovation research policy. Secondly there are bi-lateral activities and co-operation agreements with China, Indonesia and Russia and culturally motivated cross-border co-operation with Flanders and North Rhine-Westphalia regions, and with Luxembourg. There are specific cooperation projects with Brazil, China, India, Indonesia, Japan, Malaysia, Singapore, South Africa, South Korea, Thailand and USA. For this type of technological cooperation the main objective is cooperation on research excellence. The third element is the participation in programmes like COST, EUREKA. The fourth is membership of international research organisations including CERN, ESL, ESA, MBC, EMBL, and ESO.

Decision making and coordination

The processes and coordination of international activities are conducted through various mechanisms. The **Innovation Platform**, which is chaired by the Prime Minister, sets out major guidelines and foci including the alignment of priorities and the Framework Programme fo*cus.* For the Framework programme specifically there is an inter-ministerial working group (IWK). This meets every 2 months and discusses the overall Dutch position towards the various parts of the Framework Programme. The people who attend are all representatives from all the Ministries who are members of programme committees of the various parts of the Framework Programme. This committee prepares the Dutch position for the meeting of the **Dutch Competitiveness Council**. This is an official body for the cooperation between the various Ministries that are involved. The Executive Agencies are also a member of this group. The purpose of the group is internal coordination and consistency between the interventions in the various programme committees. This is an important coordination body which is chaired by the Ministry of Economic Affairs.

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[66] Source: ERAWATCH research inventory

There is also a sub-group and this meets to discuss unexpected developments or for any reason requiring a rapid response. In this group are the MEA, Ministry of Science and Education, The Ministry of Agriculture, Ministry of Transport, Ministry of Health and Ministry of Defence (because they are all involved in the main programmes of the Framework Programme). This smaller committee meets on an ad hoc basis. For the Framework programme this is by far the most important coordination body.

There are also regular meetings between the Ministry of Economic Affairs, who are mainly responsible for innovation and research in the private sectors, with the Ministry of Education and Sciences which is responsible for the public sector. They meet on a three weekly basis to discuss issues requiring coordination between those two ministries. Relatively weak co-ordination exists between these Ministries and the Foreign Ministry.

Selected Activities

Participation in European programmes is highly important in the Netherlands. The government try to ensure that European priorities (especially the ETPs) link to national priorities and programmes. The Innovation Platform, mentioned above drives and guides this process.

The Netherlands has important cooperation agreements with China which focus on basic research between research institutes and with Russia that focus on both basic and applied research. The SPIN programme in Indonesia focuses on structural cooperation between universities and research organisations in basic and applied research.

In general policy is to ensure that all national innovation programmes will have and international element. There are incentives in the form of additional financial support for SMEs and PROs to be involved in international activities, for example the EUREKA budget. For basic science there is the 'money follows researcher' scheme in EUROHORCS, which the Netherlands joined very early on.[67]

Major Challenges

Major challenges identified by the Netherlands are to avoid memoranda of understanding at the country-to-country level. For internationalisation in research activity the diplomatic driver is not regarded as significant as scientific excellence or excellence in innovation. Historical ties can make it more difficult to close internationalisation programmes due to diplomatic, cultural priorities. There is always a balancing of priorities that has to be achieved.

Major Assets

The Netherlands has started innovation programmes in each of its key priority areas and each will have an international R&D component and associated activities. It has also established a strong network of **technology counsellors** (formally titled Netherlands Officers for Science and Technology, acronym TWA). These people operate as a business science link and search for excellent research and innovation opportunities in key Dutch priority areas. They are based in various embassies around the world including the US (Washington and Silicon Valley), India (New Delhi), China (Peking), Japan, South Korea, Singapore, Finland, Sweden, UK, Italy, Denmark, and Brussels. The selection of countries in which to place these counsellors is nominally based on the 'research excellence' criterion. These officers gather and analyse information for Dutch companies, knowledge centres, universities and governmental institutions,

[67] As part of a strategy to increase the mobility of researchers within the ERA, EUROHORCs launched the successful initiative Money Follows Researcher (MFR) in 2005. This agreement allows researchers moving to other countries with research funding organisations having signed the MFR, to take with them the remainder of a current grant.

providing contact information for bilateral cooperation and answering general questions. They are intended by the Ministry of Economic Affairs to be Dutch experts 'on the spot', gathering information on the country in question and (on demand) informing Dutch SME's and institutes on the technological developments in the respective countries. The network has a home base at the Ministry of Economic Affairs (rather than the Foreign Ministry) in The Hague. In other embassies there are economic departments but these are not so specialised as these officers. The technology officers are likely to gain a much more proactive role in promoting trade and investment links in the future.

The Science Council and the Royal Academy are active actors in internationalisation. For instance the Royal Academy acts as the secretariat for CO-REACH[68] which is an ERANET with China. They also run international cooperation programmes with foreign universities and research organisations.

Strategic Intelligence

The Advisory Council for Science and Technology Policy (AWT) advises the Dutch government and parliament on policy in the areas of scientific research, technological development and innovation. The AWT is mainly active in the areas of the Minister of Education, Culture and Science (scientific policy) and of the Minister of Economic Affairs (innovation policy). It provides both solicited and unsolicited advice, and operates independently of both the Ministries and the various parties involved in the areas concerned. The subjects for the year's advisory reports are set down each year in the AWT's work programme.[69]

The activities of the Technology Counsellors are evaluated regularly on a four year basis. This is also true for all Dutch internationalisation cooperation programmes and it is a legal requirement. This is a real strategic evaluation and does genuinely result in the closure of programmes that are no longer fit for purpose.

Good Practice

The Netherlands has a clear focus in terms of the countries it selects with which to collaborate based on strong research. Positive examples of good practice in internationalisation of STI include the network of technology counsellors/officers in 12 countries around the world. This activity is evaluated regularly and is considered to be successful.

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68 http://www.nwo.nl/subsidiewijzer.nsf/pages/NWOA_6SJBRK_Eng CO-REACH is a network of European S&T policy and funding organisations involved in promoting research co-operation with China in the natural sciences, medical and life sciences, engineering sciences, social sciences and humanities. This network is intended to create coherence and synergy in Europe´s S&T relations with China. It will do so by promoting the co-ordination of China-related policies and associated research funding programmes of individual European countries, and integrating these efforts with those of other multi-lateral European initiatives, including the programmes and agreements of the European Commission.

69 http://www.awt.nl/?id=497

Switzerland

Strategic considerations and coordination

The Swiss Research system is highly internationalised, especially in terms of inward internationalisation. The policy responsibility for international science and research. The high importance international activities have for the science system is, however, not reflected in a systematic internationalisation strategy. There is no major strategic document that outlines the status quo, rationale and goals of international activities. Equally, while various departments cover the internationalisation aspect of the Swiss system, there are no horizontal units to coordinate it. However, there is a strong tradition of coordination in the country, through horizontal committees (bringing together Education, Research and Innovation) and also through the Swiss Science and Technology Council.

The two major departments responsible for research and innovation in Switzerland are the State Secretariate for Education and Research on the one hand and the Innovation Promotion Agency (within the economy ministry) on the other hand. Further, the Swiss National Science Foundation and the Council of the Federal Institute of Technology (ETH Board) are major actors with internationalisation activities on their own. The foreign ministry does not really interfere with science and research matters, the major responsibility and leadership ion terms of international agreements on science is with the science administration.

Despite a lack of strategy development, the international dimension has gained weight in recent years, both in terms of dedicated budgets and in terms of general strategic documentation. In the current 4 years plan for the science budget, there has been an increase for international activities of 15% compared to the previous 4 year plan.

In principle there has been no major shift in the basic rationale for internationalisation of research, the scientific rationale has remained strong, and international cooperation is not entirely measured in terms of innovation effects for the country.

Selected activities

In terms of industrial research, internationalisation of Swiss actors is largely focused on the participation to the Framework Programme and within EUREKA and the IMS (Intelligent Manufacturing System) Initiative. The country has established an intensive and elaborate support structure and engages in strategic discourse every time the role of this non-Member-State in a new Framework Programme has to be decided upon. There is no major further company specific support for international activity. For foreign partners, Switzerland has the very strict rule of only financing the Swiss partner, the local added value and market effect is a key in the financing of international partnerships in National programmes.

Switzerland puts a strong focus on participating in international facilities and research organisations. For the time 2008 to 2011, the country spends 480 Mio CHF for ESA alone, but only 18 Mio CHF for bilateral cooperations in Europe. While the Framework Programme has high priority, the coordination through schemes like ERANET are of lesser importance, at least in view of the policy makers. ERANET are not really part of the strategic considerations, whenever coordination with other countries is needed, Switzerland tries to do this bi- or multilaterally, even within Europe. One example for this is the so-called D-A-CH Agreement in which the German DFG and the Austrian FWF have agreed with SNF that for basic science projects grants can be transferred across borders if researchers move.

The various Memoranda of Understanding do not play a major role for the country, many of them are not active, and certainly there is no strategic evaluation as to how they could be more effective, at least at the moment. However, there is a new approach for bi-lateral international scientific programmes, designed with stakeholder involvement (see below, good practice). There is a new wave of programmes in which

the country tries to finance bilateral projects following the EUREKA model. This model has, for example, been applied to China. Each country pays their participants to project, with a coordination facilitation paid for jointly. Thus, there is a possibility for concrete collaboration projects even in application orientation with Chinese partners. The country has started to fill a gap that has become apparent in some European countries: Financing of bilateral collaboration beyond the framework programme.

Major assets and challenges

The country is extremely strong in scientific and technological position, not across the board, but in many key scientific and technological areas. In combination with stable framework conditions, a prosperous economy, a cosmopolitan attitude in Universities and the geographical position Switzerland is highly attractive for foreign scientists, especially talent (high rate of foreign PhD) and research active companies. The country has strong indigenous companies and is will embedded in global networks at all levels. It is the location of some highly regarded international research facilities and has put an emphasis in the contribution to international research organisation in general.

Further, the domestic principles of funding (collaboration between firms and Universities (institutes) fully matches the European approach, making adaptation easy. In fact, the country uses European models to design their own bilateral collaboration programmes.

The two key challenges are that the country is not a full member of the EU. Thus, in order to reap the full benefit of the Framework Programme, it has to be associated to it. This requires national debate and conscious discussion, leading to insecurity and instability in transition periods. However, as observer one is inclined to interpret this challenge as a strength, as it forces the stakeholders to justify the involvement, to think about alternatives and added value very principally. A second challenge that is discussed in the country is how to turn the strong international presence – both of firms and of scientists in public research – into a major, sustainable strength. Embedding companies and retaining staff is high on the political agenda of the country.

Strategic Intelligence

As a consequence of the associate status of Switzerland, the country is engaged in intensive evaluation of the Framework Programme, COST and EUREKA.[70] This is done on a regular basis and discussed intensively throughout the whole stakeholder community. In addition, all participations in major international organisations are evaluated on a regular basis. A mix of quantitative and qualitative methods are applied, trying to define the actual usage of facilities, the success rate in using and the effect the usage has (see the main part of this report for further detail). In addition, the Swiss government takes some effort in order to understand the scientific and technological profile of the country and the meaning of the international dimension for that profile and the scientific and technological competitiveness.[71]

A further evaluative activity is the assessment of the strength and weaknesses of partner countries. If there is a new country under consideration for international scientific or technological agreements, analytical studies are commissioned. These feed into a stakeholder discourse and help deciding on priorities.

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[70] Z.B. Balthasar et al. (2005): Evaluation der schweizerischen Beteiligung am 5. und 6. Forschungsrahmenprogramm der Europäischen Union.

[71] Out of a series of studies, one of the latest has been Schmoch, U. (2004): Innovationsstandort Schweiz. Karlsruhe.

Good Practice

There is a new wave of strategic programmes with a set of selected countries, with two level of priority. High priority countries are China, India, Russia, South Africa, of secondary priority are Japan, Korea, Brazil. For the latter the programmes have smaller budgets. The selection of countries is based on a broad consultation process with all stakeholders. To do so, existing channels of involvement are used, mainly the Rector`s Conference, the ETH Board and the SNF. The scientific priorities within the programme are defined even before the agreement are finally negotiated. This resembles the Austrian approach and gives the country a strong position in defining fields that guarantee added value for the scientists. This procedure is a mix of top down (country initiatives) and bottom up (the areas), a feature that is not uncommon in Swiss RDTI policy in general. In a second phase, and based on the bottom up discourse, the implementation of the programme is delegated to key actors in the selected areas. This is again done in consensus and with the provision of equal opportunity in terms of applying for funds. The programmes are not merely framework agreements, but they organise lab usage, exchange, mobility and concrete research project. Still, they do work on the strict principle of reciprocity, i.e. each country finances their own partners.

Further to these international programmes, there is a de-centralised approach to internationalisation. This means that rather than designing an overall strategy, the programmes are given a certain budget that is not earmarked for projects, but can and should be used for horizontal activities such as internationalisation. This budget can be used as it seems fit for the purpose of the various programme areas. The strategic meaning of this is not fully clear, as it could mean good practice as a tailor made framework for internationalisation, and it could mean an erratic spending of money for international activities or even a counter-productive blocking of international activities through programme owners. Apparently, internationalisation is part of the evaluation of programmes, and thus the ways budgets are spent are controlled for.

United Kingdom

Strategic considerations

As part of a broader upgrading of strategic thinking about science, technology and innovation policy the United Kingdom has become much more strategic about internationalisation of S&T in recent years.

In 2006 the UK set four explicit strategic objectives in relation to internationalisation:

- Excellence in research – connecting excellent UK research to the best research around the world through strengthened international collaborations and by attracting the best researchers to the UK
- Excellence in innovation – again, ensuring the UK has access to the best innovation in the world by enabling UK businesses to access international science and by attracting international R&D investments to the UK
- Global influence – by using international science to underpin foreign policy and as a tool to promote bilateral partnerships – in other words science as an honest broker in international relations
- Development – science and technology to promote capacity building and economic development in less developed countries, using research and innovation to meet the UK's international development goals.

The various ministries, agencies and semi-independent or independent bodies involved in promoting internationalisation activity for whatever specific objective are brought together in the **Global Science and Innovation Forum (GSIF)**, chaired by the Government's Chief Scientific Advisor. GSIF has agreed the four strategic objectives listed above and set out broad priority targets in terms of regions and countries. It provides a co-ordination forum and has no executive function. Individual decisions are still taken by the relevant ministry or agency. The forum allows the various actors in the policy system to improve their mutual understanding of each other's different roles (and different policy drivers) in what is a highly complex division of labour. More information on the four broad themes or goals is in the UK (GSIF) Strategy document *A strategy for international engagement in research and development*[72]. To support the first two of the four GSIF objectives (those concerned with research and innovation excellence) GSIF has decided to focus its attention on (i) those countries with most productive and excellent science base as determined by bibliometric evidence on the total number of scientific citations and the share of scientific papers in most prestigious journals and (ii) those major emerging economies which are rapidly expanding their science base to further fuel economic growth for instance consideration student numbers overseas and absolute spend on R&D[73]. GSIF note that a number of EU countries would score highly against the above criteria but prefers to focus on the EU as a single block – recognising the increasing importance and prominence of European Community instruments in this area. Taking the EU as a single entity then, the priority targets identified by GSIF are: Australia, Canada, China, the EU, India, Japan, South Africa, Switzerland and the US. In line with the co-ordinating rather than directing function of GSIF no new mechanisms are specifically proposed to operationalise these newly identified priorities: rather, GSIF hopes that the UK Research Councils will use existing schemes, perhaps streamlined to

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72 Available at: http://www.berr.gov.uk/files/file34726.pdf

73 GSIF Strategy, p33. http://www.berr.gov.uk/files/file34726.pdf

reduce bureaucracy. The opening of overseas offices of Research Councils UK in China, the US and India (to complement the existing Brussels office) can be seen as one concrete operationalisation of this GSIF recommendation.

The **Government Office for Science** (GoS, formerly the Office of Science and Innovation - OSI) provides the secretariat for the GSIF, and the Forum is chaired by the Chief Scientific Advisor. There is also an active 'officials' group parallel to the main Forum which meets regularly and handles more day-to-day co-ordination. It is expected that the creation of the new **Department for Innovation, Universities and Skills**[74] (in which GoS sits), in bringing together innovation and basic research policy with higher education policy in a single ministry, may lead to further improvements in the co-ordination of internationalisation activity.

Selected activities

Not surprisingly there are a large number of UK activities to support international engagement in R&D. The UK has a series of networks and agencies promoting STI internationalisation according to different policy objectives. The following list covers the key actors:

- **The Royal Society**[75] (The UK's national academy of science) promotes basic research links through its international programmes and builds links with other national academies of science through agreements and memoranda of understanding. This is done through an International Policy section overseen by the Society's Foreign Secretary, who is also a vice-president of the Society.
- **Research Councils UK**[76] (the umbrella organization for the UK research councils) promotes mobility and joint programmes and initiatives in basic research. The Research Councils are government funding agencies for basic research which set their own research priorities independent of ministers. They have been criticized for not having well-developed internationalisation strategies but through RCUK are now attempting a more strategic approach.
- **The British Council**[77] promotes internationalisation activity through its offices worldwide (and a network of dedicated science officers in selected countries) as part of its broader role of promoting UK education and culture. It promotes bilateral links and promotes mobility (including inward mobility). It also heavily promotes the UK as a place of learning. The Council has identified eight key goals as part of its vision for the development of this science promotion activity[78].
- The **Foreign and Commonwealth Office**[79] has an extensive **Science and Innovation Network** (established in 2000 and comprising dedicated staff in 39 missions in 24 countries and territories), co-ordinated by a **Science and Innovation Group** in the Foreign and Commonwealth Office in

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74 Created as part of the reorganization of the machinery of government following the appointment of Gordon Brown as Prime Minister of the United Kingdom. More information is available at: http://www.dius.gov.uk/

75 http://www.royalsoc.ac.uk/page.asp?id=1175

76 RCUK are opening international offices in selected key countries, including China and India' as part of a revamped internationalization strategy published in July 2007: http://www.rcuk.ac.uk/cmsweb/downloads/rcuk/publications/international.pdf

77 The British Council is an independent but government-funded body charged with promoting British culture and education worldwide. Science is a significant activity for the Council: http://www.britishcouncil.org/science.htm

78 http://www.britishcouncil.org/science-about-us-vision.htm

79 The Foreign and Commonwealth Office has identified ten priorities governing the UK's diplomatic activity. One of these is "Supporting the UK economy and business through an open and expanding global economy, science and innovation and secure energy supplies". See http://www.fco.gov.uk/science

London. Based in UK embassies and consulates abroad, the overseas Network works closely with other networks including those of the British Council and UK Trade and Investment. The FCO Network operates very much according to the overall objectives laid out by the Global Science and Innovation Forum. They aim to match this top-down prioritization with relevant bottom-up opportunities by proactive monitoring. The network is regularly evaluated to ensure maximum impact.

- **UK Trade and Investment**[80] promotes the UK as a location and partner for innovation activities as part of its mission to promote trade and inward investment into the UK. Across its network UK T&I employs around 2,300 staff and advisers, including overseas in UK embassies, high commissions, consulates and trade offices, and in the nine English regions[81]. It has headquarters in London and Glasgow. UK T&I reports jointly to the FCO and to the Department for Business, Enterprise and Regulatory Reform (DBERR).

Major challenges

Indicators suggest that the UK is a leading global partner in science and innovation activity. A key challenge for the UK is to maintain and build upon this position as other developed economies move to raise their own international activities and as emerging economies like India and China rapidly become significant STI actors. The role of policy action is mainly to remove barriers to bottom-up internationalisation activity – to make the UK more 'competitive' as a potential partner for research and innovation. There is also the scope to match up top-down strategy with bottom-up demand by putting support and funding together in novel ways as opportunities arise.

The **UK-India Education and Research Initiative (UKIERI)** is an early and significant example of this new collaborative approach[82]. The initiative aims to substantially improve research and education links between India and the UK, and is notable for the inter-agency/ministry collaboration involved in setting it up. The three main strands of the initiative are: Higher Education and Research; Schools; and Professional and Technical Skills. The Initiative also presents an opportunity for high level dialogue between the two countries on areas of mutual policy interest such as quality assurance, international standards and credit recognition schemes. Under the initiative, the United Kingdom has pledged £12 million through contributions by various UK Government departments and the British Council. Furthermore, the private sector has added £4 million through the 4 'corporate champions' BAE, BP, GSK and Shell to this fund. The Department of Science and Technology of the Government of India has pledged matching funding for science related collaboration under the initiative. The ultimate aim of the programme is to "create a 'step change' in educational relations between India and the UK over the next five years, so that in the longer term the two countries become each other's partner of choice in education". The largest part of the £12 million UK government funding will be directed towards **Research and Higher Education** collaborations, with an emphasis on promoting the formation of durable institution-to-institution links. The two principal activities will be promoting research partnerships between centres of excellence, and developing joint and dual course delivery. Project proposals are evaluated according to research merit, potential for innovation and overall benefit, with subject areas drawn from science and technology, the social sciences and other areas of economic importance in the India-UK relationship. Funding will support staff and student exchanges, promoting new links between HEIs and research centres of excellence. Research cooperation projects might include staff secondments, exchanges of postdoctoral and other

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80 http://www.uktradeinvest.gov.uk/

81 In England, UK Trade and Investment operates as the international trade arm of the nine Regional Development Agencies.

82 http://www.ukieri.org/

research workers and support for postgraduate research students in both UK and India. Collaborative delivery projects will include taught Master's courses (Full Awards), and shorter postgraduate professional courses (Short Awards). Collaborative delivery projects will normally receive support for a 3 year start-up period.

UKIERI have set a number of 'minimum targets' to be met by 2011:

- 50 new collaborative research projects, including 5 'major' projects linking centres of excellence
- 40 new UK award programmes delivered collaboratively in India with 2,000 Indian students enrolled
- 300 additional Indian research students, postdoctoral researchers and staff will have worked in the UK
- 200 UK researchers worked in India and 200 UK undergraduate students supported for studies in India
- 2000 Indian research students completed research degrees in the UK through collaborative delivery

Clearly these are largely activity indicators rather than impact indicators.

Major assets

A key asset for the UK is the **range of agencies and actors** with a relatively **clear and well-understood division of labour**[83] between them and, crucially, an apparently **high degree of co-ordination** and agreed, well-understood **high-level objectives**.

A further key asset is the series of **complementary international networks with different focuses**. Of course this asset could also become a liability should duplication or confusion arise through poor co-ordination or a lack of explicit, share objectives. It is hard to assess whether the multiple overseas networks are truly complementary or duplicative and much depends on how effective the co-ordination of GSIF truly is. However it is clear that the longest standing networks – the BC, FCO SIN and UK T&I networks – are highly co-ordinated. How the new RCUK overseas offices will fit into this established picture is difficult to predict.

Strategic Intelligence

The intention at the level of GSIF is to take a more evidence-based approach to high-level strategy-making. GSIF have already commissioned bibliometric studies[84] and other studies[85] to support policy-making in this area and there are plans to use horizon-scanning/foresight approaches to explore different future scenarios. Evaluation also feeds into internationalization policy, with regular evaluations of the FCO SIN network and periodic evaluations of individual internationalization programmes.

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83 The division of labour as regards internationalisation of ST&I appears to be clear and well-understood within the policy system. It is hard to judge how well understood it is in the wider science and business communities.

84 See: http://www.dius.gov.uk/pressreleases/press-release-20070712a.htm

85 See for instance: http://www.berr.gov.uk/files/file30063.pdf

Good practice

GSIF is felt to be evolving into an effective high-level body for co-ordinating internationalisation strategy at the inter-departmental level. GSIF provides an opportunity for all the key government players who have a stake in the strategic areas to:

a) understand better what each other is doing;

b) understand where they might actually work together better; and

c) understand where there are gaps or potential tensions that might need addressing

It is probable that the lack of executive authority of GSIF is a strength rather than a weakness – it really is a co-ordinating forum rather than a oversight board or committee, allowing the individual priorities and objectives of different departments and agencies all with an interest in internationalization driven by different policy agendas to come together to agree on common themes.

The emergence of RCUK and research council internationalisation strategies should also be seen as good practice, allowing for consideration of national S&T activities in an international context. How the overseas offices being opened by RCUK will fit into and work with the existing set of networks remains to be seen. Of course the long-standing role of Royal Society is also significant here. The fact that the Society is very effective in bilateral activity at the national academy level may even free up government attention for more strategic objectives.

Finally, the development of a long-term planning process for infrastructure needs of UK science has helped identify the UK's priorities for international infrastructure projects. The resulting **Large Facilities Roadmap** is periodically updated in consultation with the scientific community. Working together, the UK Research Councils are responsible for producing the Large Facilities Roadmap . This Roadmap provides UK policy makers and researchers with a clear, strategic view of how best to provide scientists access to world class research facilities and also how best to manage the investment of public funds in such facilities. Covering all academic disciplines funded by the Research Councils, including social sciences and humanities, the Roadmap provides a comprehensive picture of the new facilities which are already under construction in the UK, and provides details of potential large facility and infrastructure projects that the Government and the UK's Research Councils would like to see available to researchers over the next 10-15 years. The Roadmap also provides a basis for discussions with international partners about future investments.

The Roadmap is not a formal prioritisation for spending purposes – there is a parallel exercise conducted for access to large capital funding which draws upon the Roadmap. Rather it presents an agreed statement of likely future needs and how these can be met. The roadmapping process starts from the recognition that each need can in principle be met in one of three ways: as a national (UK) facility; jointly with European partners, either in the UK or elsewhere; or jointly with other global partners (such as the United States), either in the UK or elsewhere. Planned developments already present in the European level (ESFRI) Roadmap are considered in the UK Roadmap for the extent to which they might meet the needs of the UK research community. Crucially, because prioritisation over needs and likely projects which would meet those needs within a relatively fixed science budget envelope is conducted within (and then between) the research councils, rather than a higher political level, a real debate about the 'opportunity costs' to funding for other fields of research of investing in a large national or international facility or membership is forced on the scientific community clamouring for such facilities or memberships.

Most recently the UK has reorganized responsibility for large infrastructure intensive science through the creation of a single **Science and Technology Facilities Research Council**. The council brings together responsibility for the operation of all UK-based large-scale research facilities (formerly managed through the Council for the Central Laboratory of the Research Councils and the management of memberships of

international research facilities and projects formerly vested in individual research councils. The decision to consolidate both activities in a single facilities council was probably at least partly driven by the need to protect core research council budgets from variations in international subscription costs from unpredictable exchange rate movements.

Denmark (additional mini-case)

Strategic Considerations

In 2005, the Danish Government set up a **Globalisation Council**[86] in order to discuss how the Danish society might meet the challenges of globalisation and to advise on a strategy for Denmark in the global economy. This strategic review was a top down implementation with instruction to conduct the process directly initiated by the Prime Minister's office. The subsequent process was steered by the Prime Minister, who chairs the Council and has been heavily involved in its ongoing work.

Decision making and coordination

At the onset of the strategic review process a set of key issues were identified as important for consideration, including education, research and innovation. Each issue was allocated a number of national or international experts (key persons) who were invited to open the debate by briefing the Globalisation Council. The process was organised through a series of expert hearings, held each month outside Copenhagen. The process was strongly neo-corporatist and the council comprises senior business people, trades union representatives and representatives of the university and research world as well as the Prime Minister and other senior ministers.

The Ministry of Business and Industry jointly with the other Ministries - The Ministry of Foreign Affairs, The Ministry of Education, The Ministry of Science, Technology and Innovation – acted as secretariat, supporting the work of the Council. For each event or meeting of the council group the secretariat would prepare background reading and analysis, acquiring relevant input on the various issues. Some 14 hearings of the Council were held at which contributions from 48 international and Danish speakers were heard and discussions held with 111 representatives of organisations and other individuals specially invited to the meetings. Denmark's consulates and embassies provided supporting information according to requests about specific policies or regions. Indeed the whole apparatus of Government was mobilised for this exercise.

As a result of the initiative the Council produced a catalogue of some 350 initiatives for implementation, organized under 14 'focus' areas:

1. World top performing primary and lower secondary school system
2. All young people should complete a general or vocational upper secondary education programme
3. A coherent education system and professional guidance
4. At least 50 per cent of young people should complete a higher education programme
5. Education and training programmes with a global perspective
6. World top level short-cycle and medium-cycle higher education programmes
7. World top level universities
8. More competition and better quality in public sector research
9. Good framework conditions for companies' research, development and innovation
10. Stronger competition and greater openness and transparency to strengthen innovation
11. Strong interaction with other countries and cultures
12. More high-growth start-ups

[86] Globalisation Council English website: http://www.globalisering.dk/page.dsp?area=52

13. Everyone should engage in lifelong learning

14. Partnerships to promote the implementation of the Globalisation Strategy

Each focus area considered has a number of objectives. For example, the objectives under 'More competition and better quality in public sector research' are:

- Publicly-financed expenditure on research and development should reach 1 per cent of gross domestic product (GDP) in 2010.
- Public and private companies together should spend at least 3 per cent of GDP on research and development in 2010.
- Public sector research should be innovative and of top quality.
- Public sector research should be relevant and promote prosperity and welfare.

Finally, a number of (often specific) 'key initiatives' are then identified to map onto these objectives. To illustrate, the most important listed under the 'research' focus area include:

- More funds for public sector research
- 50 per cent of research funds to be subject to competition
- In future a proportion of the funds available should be allocated to large-scale, long-term projects in competition between universities rather than individual researchers or groups
- Research grants should cover the full costs of performing research
- Increased use of large, long-term research grants
- Specific funding for research infrastructure and a long-term Danish strategy for investments and priorities of major research infrastructure
- More funding towards strategic research
- A better basis for prioritizing according to social and business needs
- More systematic evaluation and monitoring of research quality
- More national co-financing of Danish participation in international research cooperation

Selected Activities

The **Innovation Centres Denmark** concept was created directly as a product of the Globalisation Council strategic review. This is a completely new type of organisation which brings together the previous relevant activities of the Minstries of Foreign Affairs and of S&T. The first centre has opened in Silicon Valley, California[87] and the second in Shanghai[88]. A third is planned to open in Munich shortly. Each center is technically a Danish foreign mission, but the staff are not only foreign ministry diplomats. Each centre has its own profile and brings together various promotion and internationalisation activities and personnel (ranging from basic research through to trade and investment) under a single roof. The number

[87] English language website: http://www.siliconvalley.um.dk/

[88] English language website: http://www.shanghai.um.dk/en/Frontpage.htm

of staff in each centres will vary – for example there are 6 core staff in the Innovation Centre Denmark - Silicon Valley. The trade promotion activity of the Invest in Denmark network (Danish Trade Council) has also been brought into the Innovation Centre Denmark model. This stems from the belief that there are two ways that Denmark can acquire new technology: firstly, either to encourage people to invest in the country; or secondly to take Danish companies and institutions to where the technology is being created. This is an effort to try and align the outward looking and inward attracting activities which in reality attempt to target many of the same actors and sectors.

Most interestingly, a specific recommendation of the Globalisation Council was that Danish representations abroad offer 'incubation' services for Danish firms seeking to start doing business in that country, and the Innovation Centre model includes this incubation service. Other services offered to Danish business are more traditional 'innovation watch' and 'match-making' ones. The precise mix of services on offer is specific to each centre: for instance the Silicon Valley sector focuses on specific sectors, namely ICT, Life Sciences and Renewable Energy. There are also Virtual Innovation Network points attached to the Innovation Centres, which are existing representations of the Ministry of Foreign Affairs which are now being steered more towards innovation. The networks submit projects to be undertaken every year and the government selects four or five for funding. They networks do not have their own structure and budget as an Innovation Centre does.

The long-term plan is to open at least 8 such centres in total. The choice of location of the Innovation Centres was achieved through assessment of Denmark's innovation environments in terms of strengths and weaknesses. The location of the first centre, Silicon Valley is one that most countries would identify no matter how the desired location analysis was conducted. In Denmark there was much more discussion about whether the second Innovation Centre should be in Boston, because Denmark has a good bio-tech environment, but the actual choice was Shanghai. From objective criteria Denmark might have chosen Boston but for longer-term reasons and to maintain momentum for introduction of more innovation centres Shanghai was selected.

Major Challenges

The Innovation Centres are tasked with coordinating more conventional trade activity and bringing this in line with the innovation activity. As part of their remit the innovation centres have an earning target of a million Danish krona to meet. They have to return 30% of the cost of running the centre from their activities.

Major Assets

Each Innovation Centre is a co-financing agreement between the Ministry of Foreign Affairs and the Ministry of Science, Technology and Innovation (MSTI). The MSTI have their own member of staff focusing on making agreements and contacts with basic research institutions. For instance, in California the relevant person has been instrumental in making agreements with Stanford and Berkley about the swap of PhD students from Copenhagen institutions. That person is taking care of the basic research activity.

Strategic Intelligence

Due to the newness of the instrument the Danish Government are currently in the process of defining evaluation criteria for the Innovation Centres. These will be partly based on the services the centres are providing and the companies and institutions that have used the centres will be canvassed for their opinions.

Potential good practice

The review itself is viewed as a 'good practice' because of the breadth of scope yet depth of detail in terms of recommendations. In particular the involvement of the Prime Minister throughout the process has ensured that real outcomes have been achieved in a relatively short timescale. An impact of the process has been the spurring of Danish missions around the world to collect data in support of decisions to prioritise future Innovation Centre openings.

The one-stop Innovation Centre model is clearly also potentially an example of good practice, although it should be noted that many of these activities (with the exception of incubation platform-type services) were already offered separately in the past. In the absence of concrete evaluation results or even informal or anecdotal evidence it is too early to make a real judgment – and it should be noted that much is likely to depend on whether the right decision is made in terms of priority country and in terms of the precise focus decided for the centre.