Activities of EU Member States with Regard to the Reform of the Public Research Base

by the ERAWATCH NETWORK ASBL

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Part A - Research reform

Part B - International cooperation

Part C - Industry Engagement

Activities of EU member states with regard to the reform of the public research base

1 - Summary

1.1 This report

This report presents the findings of three linked desk studies carried out under the auspices of the Erawatch project, 'Activities of EU Member States with regard to the reform of the public research base'. The report comprises three parts:

- Reform of the public research base in the EU
- Intra-EU research cooperation
- Industry engagement

1.2 Reform of the public research base

1.2.1 Trends

The period 2000 – 2007 has seen widespread member state policy activity in pursuit of research reform, and particularly in the university sector. Only Greece, Ireland, Malta, the Netherlands and the UK have not introduced significant new legislation in that time, although the relative calm in the Netherlands and the UK reflects a much earlier adoption of these principles and goals.

This modernisation process has been driven on the one hand by EU-level policies, to establish a European Research Area (ERA) and a European Higher Education Area (the Bologna process), and on the other hand it is the result of a more general commitment to introduce the principles of new public management and member states' ambitions to increase the social and economic return from public investment in research.

These reforms have included developments at the national and institutional levels, including:

- Introduction of legislation to create more autonomous institutions, with increased management autonomy and reduced central management by the state;
- Introduction of national research policies with explicit thematic and procedural strategies and a commitment to increasing social and economic benefits, and a competitive economy in particular;
- Introduction of more competitive funding models, and a shifting balance of funding in favour of performance-related income and mission-oriented funds.

Governments are not withdrawing from their responsibility or influence for the public research base but are using new methods of steering the research base to align with policy priorities. A handful of countries have followed the New Public Management approach of writing performance contracts with the universities.

Member states report a growing interest in performance monitoring and evaluation, which is a corollary of the increasing autonomy of public research institutions and a need for budget holders to be able to demonstrate efficient and productive use of public funds. Several countries have created new institutions external to the universities with a quality control mission. The research quality control system that stands out as distinctly different is the UK's Research Assessment Exercise (RAE), which has led to a situation where some 50% of block funding is awarded to the top 10 research universities. These leading institutions account for around 30% of total university research capacity.

A growing number of European member states has published national policies to promote and facilitate international research cooperation, and in particular to increase and strengthen links to leading scientific nations and emerging economies outside the EU. There is a growing strategic interest in the subject at the university and institute level too. International relationships are coming to be seen as a vital means by which to drive research excellence, attract students and staff and sustain the institution in the longer term.

Increased interaction between universities and industry is a long-standing policy objective in all Member States and many have long-running programmes that promote both 'pair wise' research cooperation between companies and universities as well as the formation of more extensive networks to facilitate diffusion and valorisation.

There is evidence of renewed efforts to promote industry engagement and not simply through project level cooperation, but also through for example the direct engagement of the private sector in the governance and leadership of universities and the encouragement of strategic research partnerships with individual companies.

There is little evidence of systematic rationalisation and concentration of research institutions, and few member states are actively looking to intra-EU cooperation as a means by which to improve coordination and reduce fragmentation. On the funding side, intra-EU joint research programmes are in a minority and have very small funds at their disposal. ERA-NET and Article 169 initiatives have provided a significant boost, however it is not an evident priority.

Researcher mobility and career enhancement is developing only slowly, and the opening up of national programmes is not an evident priority, although there are exceptions and increasing experience of how to reconcile domestic agenda with internationalisation.

Overall, the process of reform is widespread if still rather uneven and suggests that there is an important and continuing role for the European Research Area, through more and better information sharing about reform and support for EU-wide research and experimentation into the various aspects of reform that have proved to be particularly challenging, from novel funding models to new governance structures to new ways to encourage internationalisation.

1.3 International research cooperation

1.3.1 Trends

In many EU member states, policy makers are showing increasing interest in international research cooperation, motivated by the intrinsic nature of research itself as well as a multiplicity of external factors from international relations to global trade.

Historically, governments and scientific administrations have tended to simply facilitate what is an organic, bottom-up process. This policy position is in flux however, with the largely 'hands off'

approach being replaced by a hybrid approach that combines a more strategic view of collaboration with the established concern to ensure the best conditions for international research cooperation. This evolution is part of the wider reform agenda, with policy makers, research administrations and institutions striving to make research budgets work harder.

A significant trend is the extension and globalisation of MS research policy, with the focus moving beyond Europe to new strategic partners, notably China and India. Future trade relationships and emerging scientific prowess are becoming more important determinants of the shape of collaboration. In addition to extending geography, there is an ambition to do more than promote domestic interests, with a public commitment to contribute significantly where possible to a variety of emerging global challenges, from climate change to poverty.

MS are increasingly competing with one another for the attention of the world's leading researchers, as well as with their counterparts in other parts of the world, from Australia to Japan to the US.

Overall, national policy makers have a broadly similar set of objectives for international research activities, which is:

- Making all domestic research more international in outlook and connectedness;
- Making best use of existing, dedicated international schemes;
- Making strategic use of research in the international arena; and
- Fulfilling one's science-based obligations to the international community.

For universities and research institutions, the benefits sought from taking a more strategic approach to the promotion, management and facilitation of international research cooperation tend to revolve around the organisation's international standing and its vitality and sustainability as a centre of excellence in the longer term.

The volume of international collaboration is substantial, with bibliometrics studies suggesting that 20-40% of national research output has an international dimension, and that this is increasing at a rate of 5-10% a year, substantially ahead of growth in research output more generally. The EU RTD Framework Programme has been an important contributor, but the dramatic growth in the domestic research system in China is an increasingly important factor.

Research quality is the one dimension where analysts have tried to identify and test the benefits / outcomes of international collaboration, and recent data suggest there is a very significant gain in terms of research quality and impact, as revealed by academic citations. In the case of the UK for example, an average impact rating of 1.21 for domestic clinical sciences papers compares with an average rating of 2.61 for 'international' papers with authors resident in the UK and France. The international gain over the average figure for national papers is the same for almost every country pairing and discipline.

International research cooperation appears in many guises, from the ad hoc writing of joint papers that arise out of informal contacts at international events to fixed-term visiting fellowships at overseas institutions to cross-border collaborative research to the creation and operation of international joint research centres.

While the great majority of international research collaboration is informal, ad hoc and driven bottom up, most European MS maintain tens of bilateral intergovernmental research agreements with other European countries, which often provide a framework within which the informal, researcher driven collaborations, numbering in their thousands, operate.

In addition to bilateral agreements, the EU has an impressive track record in the creation of major scientific and technological facilities, based in *multilateral* inter-governmental research agreements.

Many of these multilateral agreements are linked to specific research and technology institutions or programmes, and are motivated by a desire to manage the economic implications of the commitment to be at the forefront of advances in a broad spectrum of research domains, often dual use, from space to particle physics to molecular biology.

The motives and policies associated with intra-EU research collaboration echo those of international research collaboration in general, although there is a stronger focus on regional cohesion and international relations than is the case for international links more generally.

In terms of patterns of collaboration, a majority of these intra-EU cooperations are entered into with immediate neighbours and those close by in cross-border regions. France and Germany appear to be the most active proponents of intra-EU cooperation, with wide-ranging agreements with most European member states, and with the geographical mix extending in line with European enlargement. This proactive position is evident in the distribution of counts of intra-EU bilateral research agreements. France and Germany are also the two member states where public policy statements are openly committed to helping to deliver on the objectives of the European Research Area.

The forms of collaboration appear broadly similar too, with a predominance of researcher mobility and joint seminars and symposia. However, within this picture, joint research is more in evidence, perhaps reflecting the existence of the EU RTD Framework Programme.

The EU RTD Framework Programme has been an important feature of the research landscape for the past 20 years, and as such EU researchers have a track record in strategic, large-scale international research cooperation that is arguably absent anywhere else in the world.

For smaller member states and in particular the new member states, the EU RTD FP has been a hugely important source of additional funds nationally, and a source of uplift for quality at the national level, through the use of competitive calls and through the association with research groups in other countries. It has also been a source of learning about how to collaborate across borders, and work well within large, geographically distributed and multi-stakeholder consortia. In this sense, intra-EU collaboration has been fundamental to research reform and the promulgation of the ERA.

In several member states, such as Germany and the UK, there is an explicit separation of the policy lead and administration between international research cooperation in Europe, and beyond. This is driven by differences in funding and critically by the fact that EU member states are paying tens if not hundreds of millions of euros each year, through membership subscriptions and other budgetary appropriations, into half-a-dozen EU-level programmes, and most notably the EU RTD Framework Programme. Securing a proportionate share of those EU budgets is a major undertaking, with target income often approaching the scale of a small national research council.

1.3.2 Implications for ERA

Intra-EU research cooperation clearly has a role to play in the future of research reform and institutional strengthening at the level of individual MS, and one can see several possible implications for the future of ERA.

There would be value in further work to extend and develop the available evidence base, to reveal patterns, trends and impacts of international research cooperation in general and intra-EU cooperation in particular.

The EU RTD Framework Programme already provides substantial and significant support for intra-EU collaboration, and its broadening mechanisms appear to align well with MS policy makers' ambitions to internationalise their domestic research base further still, including:

- The provision of funds to pay for research cooperation with scientists and engineers in third countries;
- The extension of European fellowship programmes to include candidates resident in other parts of the world;
- The financing of international flagship projects, where non-European countries might be significant sponsors;
- The development of EU-wide strategies in challenging areas from next-generation large-scale research infrastructure to policy research;
- The promotion and possible financing of joint programmes, which bring together interested member states to jointly fund research in pursuit of common objectives, such as policy research

1.4 Industry engagement

1.4.1 Trends

The desk study has confirmed that industry engagement is a major focus for research reform across EU member states, and this subject has been explored in a little more detail through institutional case studies in three member states.

In principle, business engages with public research institutions through one or more of the following six strands

- Recruitment of researchers
- Purchase of research outputs
- Strategic research partnerships
- Appointments of business people to governing bodies and senior posts
- 'Privatisation' of elements of the research delivery system
- Endowments given to research institutions

In all three cases, it is clear that the national policy and legal environment has evolved in the past 5-10 years and has become increasingly concerned to improve and increase industry engagement in public research. The Lisbon agenda has reinforced this national policy trend, with universities at the forefront of national and regional initiatives to attract inward investment from leading global technology companies.

In all three cases, national research strategies are evolving into what might be called research and innovation strategies, where a commitment to deliver research excellence sits alongside a parallel commitment to increase the benefits to the national economy deriving from this significant public investment and social activity. In all three cases, there is evident involvement of the private sector in strategic planning exercises, as architects and consultees.

In all three cases, one can see increasing levels of industry engagement at the institution level in appointments to governing bodies, the involvement / consultation with private sector around university strategies, public-private strategic research partnerships and the outsourcing of key 'innovation' functions. Appointments to senior administrative posts are increasingly common, however private-sector appointments to the most senior posts are not much in evidence in the three cases in question.

In the Netherlands, the Association of Universities in the Netherlands (VSNU) reports a doubling of research income from the private sector, in the 10-year period from the mid-1990s. In the UK, monitoring data show long-run, year-on-year growth in private sector involvement across HE in governing bodies, co-publications, research income, licence income and so on.

1.4.2 Implications for ERA

Industry engagement is at the heart of MS reform agendas and policies to strengthen domestic research more generally, and it is a trend that appears to be diffusing and strengthening. This ambition fits closely with the Lisbon agenda and the economic objectives for the ERA.

MS policies combine principled exhortation with elements of structural reform in for example the rules on membership of the governing bodies of research universities and small, dedicated measures to encourage and part fund increasing collaboration, whether through national foresight programmes, joint research or research commercialisation.

Change on the ground is gradual however, with seemingly uneven development across the EU wherein countries such as the Netherlands and the UK are perhaps a decade in front of many other MS as regards the policy commitment to industry engagement in research. The limits to engagement are manifold, however two features stand out in particular, which is the primary focus of public research organisations on the advancement of knowledge, a mission that is at one point removed from business objectives, and secondly the fact that businesses' primary relationships with public research is recruitment and the purchase of technical services, and not collaboration. Indeed, when it comes to innovation most businesses would expect to collaborate with other businesses, clients, suppliers even competitors, far more frequently than they do with the research base.

The implication for ERA going forward is one of support and encouragement to MS, whether

- Leading by example, through the open and careful development of new measures and the evolution of support for business partnerships within existing measures;
- Strengthening the evidence base;
- Facilitating learning and information exchange amongst MS.

1.5 Concluding remarks

The study has confirmed there is widespread commitment to the modernisation agenda across the EU member states, with significant legislative and institutional reform having taken place in most if not all countries.

The transformation remains a work in progress, and is somewhat uneven. This is natural given the different starting points of the various national systems. Several member states are further ahead than the majority in the creation of a dynamic community of research performers with strong links to education, to business and wider society and to the global scientific community.

The new member states have tended to come to research reform somewhat later, and with a very different legacy. There are major structural differences too and in particular the importance of the institutes of the academies of science within the national research systems. There has been progress too in the several larger EU member states where research has been dominated by a small number of large, vertically integrated institutions that set priorities and conduct research.

The main dimensions of change have been the separation of the national infrastructure for budgeting and priority setting from the institutions invited to carry out this research. Increasing institutional autonomy is used to create competition amongst research performing organisations, to encourage more relevant and better science, and to improve transparency around the performance of the system.

At the member state level, legislating for institutional autonomy has been accompanied by closer government interest in the formulation of research priorities of national significance and the rebalancing of funding in favour of more competitive models, with more targeted programmes and reducing block grants. The introduction of performance-based systems within the institutional funding arrangements is beginning, however remains an uncertain and contentious development trajectory.

In procedural terms, research strategies are making renewed commitments to increase industry engagement and developing new policies to encourage and require research institutions to become more active in the international arena, and in particular with emerging scientific and economic power houses in Asia and the Far East.

At an institution level, reform is evident in the reduction of direct political influence and the attenuation of academic control by business and community interests within university governing bodies. University management teams are emerging as real executives with significant strategic and management autonomy, and a process of marketisation and professionalisation is evident across key functions from human resources to external relations.

One can expect the further diffusion and consolidation of these established trends, however there are a number of areas where reform has been less evident.

EU-level policies and in particular the ERA and Bologna processes have been important facilitators, helping to create a shared vision of a more dynamic public research system and providing leadership on key challenges and support through targeted measures.

However, there is still much that might be done to help realise the ERA, and one might imagine that the rate of progress and the good sense of the changes proposed and implemented would give a useful boost through action on some or all of the following dimensions:

- More and better information on the nature and extent of progress on reform;
- More and better information on the results of reform, in terms of quality, economy and impact;

- More opportunities for sharing experience across people and institutions involved with the implementation of reform;
- More commitment to creating European centres of excellence with substantial international remit and sponsorship;
- More commitment to variable geometry instruments, like Article 169 possibly with European funding to match member state funding;
- More commitment to measures to support collaboration with researchers in third countries; and
- More investment in research into the process of modernisation and reform, to explore options and solutions, at key sticking points.

2 - Introduction

This report presents the findings of three linked desk studies carried out under the auspices of the Erawatch project, 'Activities of EU Member States with regard to the reform of the public research base'.

The report comprises three parts, one for each of the three studies:

- Reform of the public research base in the EU
- Intra-EU research cooperation
- Industry engagement

Research reform is the common thread, linking the three parts.

Each part is organised around the same three sections.

- Overview: status of knowledge
- Recent activities by member states
- Major EU-wide trends and corresponding policy implications for ERA

Each part is a digest of a more detailed policy note of 30 pages plus, annexed to the report for reference.

Part A - Research reform

3 - Introduction

Part A explores the political and institutional nature of reform in the research base over the last few years in both universities and in public research institutes, and draws out some of the trends and approaches to reform in terms of regulation, policy and programmes. It provides the background as to the principal motives and directions of reform for Parts B and C.

4 - Overview

4.1 The need for reform

Early milestones

There is a long history of discussion in Europe concerning the need for the reform of its research institutions, however the publication by the European Commission of its communication 'Towards a European Research Area' (January 2000) was a turning point. The Communication elaborated a series of characteristics that the reinvigoration of research in Europe would need to overcome, and several of these challenges have been at the heart of the reform process in the period 200-2007. The following extract is taken from the opening chapter, in which the situation was presented and reform objectives rehearsed.

Decompartmentalisation and better integration of Europe's scientific and technological area is an indispensable condition for invigorating research in Europe. We need to go beyond the current static structure of "15+1" towards a more dynamic configuration. This has to be based on a more coherent approach involving measures taken at different levels: by the Member States at national level, by the European Union with the framework programme and other possible instruments, and by intergovernmental cooperation organisations. A configuration of this kind would make for the essential "critical mass" in the major areas of progress in knowledge, in particular to achieve economies of scale, to allocate resources better overall, and to reduce negative externalities due to insufficient mobility of factors and poor information for operators.

At the level of universities and research institutions, the challenges were increased cooperation in pursuit of critical mass and excellence, greater interplay across disciplines, increased mobility of people and other factors and perhaps most urgently improved industry science relations.

In addition to the European Research Area (ERA), reform has also been influenced by the Bologna Accord and the related efforts to construct a European Higher Education Area (EHA), a reform process that began formally in 1999. The Bologna process as it has come to be known has sought to create a more singular and uniform higher education system in Europe, pushing up educational standards overall, increasing the attractiveness of European education to non-Europeans and facilitating the mobility of both students and workers mobility. Here the reforms have involved higher education governance, the social dimension of higher education and research and the values and roles of higher education and research in modern, globalised and increasingly complex societies with the most demanding qualification needs.

Boosting the reform agenda

The Green Paper on the European Research Area (ERA)[1] says that the ERA should have the following features

- An adequate flow of competent researchers;
- World-class research infrastructures;
- Excellent research institutions;
- Effective knowledge sharing, notably between research and industry;
- Well-coordinated research programmes and priorities; and
- A wide opening of the ERA to the world.

This has a number of implications for the knowledge infrastructure (many of which have been described in a recent Communication[2] on university modernisation):

- The knowledge infrastructure must have a shape, size and governance arrangements that enable it to respond both to the policy needs of the member states and of Europe. This includes a reduction in the fragmentation of the system;
- Institutions must have sufficient autonomy to devise and implement their own strategies – responding to the needs of society expressed via incentives at both national and international levels;
- They also need sufficiently strong internal leadership (supported by governance mechanisms) to ensure that they are not 'locked in' to internal, academic priorities;
- They require funding models, quality controls and accountability mechanisms that reward both excellence and external relevance;
- They need effective ways to interact with other knowledge producers and users in society; and
- There should be freedom and incentives to encourage the institutions to operate globally.

In addition to these needs, there are needs and solutions implemented by national policy makers that this paper draws together to look at how policies are affecting the practical implementation of reform. In order to investigate responses to these drivers this paper is structured around the following four areas:

- New regulations for universities and institutes concerning autonomy, accounting, performance assessment and more effective interaction with commercial and public sector producers;
- New governance models for steering the public research base, including the universities, and other public research institutions including the role of demand side policies, mission oriented research, involvement of stakeholders in R&D priority setting, etc);
- New or changed funding models for universities and institutes (including those aimed at improving the quality and relevance of research); and
- New initiatives and incentive schemes for accelerating knowledge transfer from and to the public research base.

The Communication "Delivering on the Modernisation Agenda for Universities: Education, Research and Innovation" underlines that universities will not become innovative and responsive to change unless they are given real autonomy and accountability. In return for being freed from

1 European Commission Green Paper the European Research Area: New Perspectives (Com(2007).

2 European Commission, Delivering on the Modernisation Agenda for Universities: Education, Research and Innovation, COM(2006).

over-regulation, it is argued that higher education institutions (HEIs) should accept full institutional accountability to society at large for their results.

This challenge to institutions to become more productive, innovative and accountable has required changes in regulation and new internal governance systems based on strategic priorities and on professional management of human resources, investment and administrative procedures, and efforts to overcome fragmentation.

4.2 New legislation

The period 2000 – 2007 has seen widespread and intensive member state policy activity, in pursuit of reform in the university sector. This is driven in part driven by the Bologna process, which is sometimes used as a trigger for wider reforms, but more typically it is the result of a more general commitment to introduce the principles of new public management on the one hand and a desire to increase the social and economic return from research investment on the other.

Only Greece, Ireland, Malta, the Netherlands and the UK have not introduced significant new legislation in that time. The relative calm in the Netherlands and the UK reflects a much earlier adoption of these principles and goals.

Exhibit 1 presents a digested summary of a review of higher education reform across the EU for the period 2000-2005,[3] which reported an emphatic increase in the managerial autonomy of universities, with 20 of 28 member states being judged to have implemented policies to strengthen institutions strategic independence in the period. This trend was mirrored to some extent by the number of member states where state or academic control was judged to have decreased in the period.

Exhibit 1 Three dimensions of influence and reform in EU higher education, 2000-2005

	State	Academic	Managerial
Increasing influence	12	12	20
No change	7	10	8
Decreasing influence	9	6	0

Source: Adapted from CHEPS 2007

The picture is not clear cut at this level of analysis, and there were also examples of countries where both state and academic influence had increased in the period. Increasing state control of universities is contrary to trends reported elsewhere, however upon closer inspection this development does not signal a move to closer control and micro-management but rather a more explicit and strategic engagement of policy makers with university performance.

3 CHEPS, CHE, ESMU and NIFUSTEP, The Extent and Impact of Higher Education Governance Reform Across Europe, Final Report to the Directorate General for Education and Culture of the European Commission, Contract No 2006-1407/001, Twente: CHEPS, 2006

4.3 New governance models

Historically, 'Research Councils' both set priorities and did research (and in other parts of the world like South Africa and Australia that built their research institutions on former British models, they still do). Comparatively few of the EU-15 still follow this practice; France (especially its national centre for scientific research, CNRS) and Spain (Spanish Council for Scientific Research, CSIC) maintain large scientific research institute systems that function in this way. Germany retains large institute systems. In the Netherlands, the KNAW institutes and, on a small scale, in Austria the Academy of Sciences institutes work in this way, as do some of the UK Research Councils – but these are in systems where there are also alternative funding sources and research performing organisations.

The last two expansions of the EU have brought in 10 former Central and Eastern European (CEE) countries, which used to operate under a system where a national academy of sciences funded and operated its own set of scientific research institutes. Slovenia and the three Baltic states have separated the research-performing institutes from the academies. (Estonia merged the institutes into the universities.) The other six former CEE states continue to operate in the previous, integrated way, reflecting the power of the scientific establishment in those countries. These academies are in practice rather autonomous from central government and other stakeholders.

In France, since the 1960s the institutes of CNRS have been increasingly integrated into universities, so that 80% of CNRS researchers now work on a university campus. Others have followed suit since the 1990s. The retention of some institutes by UK Research Councils represents the rump of a process of separation that began decades back (and largely comprises a mix of facilities-based institutes providing instrument access to the university community, national surveys and deep specialists, such as the medical research institutes). Thus, while the entry of CEE states has increased the number of such integrated organisations in the EU, the longer-term trend is towards separation of priority setting and research performance in the scientific research institutes. The expansion of research in the university system also appears to be an evident trend, pursuing the synergy and social benefits of combining research with education.

In most countries, the applied research institute structure is fragmented, often by branch of industry. Several countries have major, divisionalised applied research institutes, all of which have attempted internally to restructure over the past decade:

- Austria (Austrian Research Centres), a conglomerate originally based on the Seibersdorf institute to which others (e.g. Arsenal) have been added and which is increasingly a joint owner of competence centres with universities and industry
- Finland, where the Technical Research Centre of Finland (VTT) has internally restructured itself to focus more on technologies and less on branches of industry
- The Netherlands, where the Netherlands Organisation for Applied Scientific Research (TNO) has undergone a similar transformation
- Germany, where the Fraunhofer Gesellschaft continues to explore stronger links between its individual institutes
- Sweden, where the Industry Ministry has successively encouraged mergers among the institutes and has now created a structure of four fairly large, technology-based (as opposed to the previous branch-focused) institutes
- Denmark, where the Advanced Technology Group (GTS) institutes (they are not commonly owned but receive their block funding through the GTS umbrella organisation) have successively merged, halving the number over the past decade

4.4 New research funding models

Reform is evident in changing funding models, with increasing use of targeted funding on the one hand, through programmes and projects, and the introduction of a performance related element to institution-level funding.

Most university funding systems have a 'binary' character, split between institutional block funding and more strongly contested project-based funding of researchers and research centres. By and large, universities are free to use the block funding as they see fit, for longer-term investment and strategic investment, and there is little sign that this freedom will be taken away. Project funding complements this longer-term funding stream, providing the research system with a more granular level of quality control and a means by which to achieve shorter-term flexibility and thematic evolution.

The project component can do more than assure quality. It can be used to signal the need for new behaviours, just as the Framework Programmes for example have signalled to European research performers the desirability of greater international collaboration. A recent OECD study[4] reported that member states are extending funding instruments, with mechanisms being added to focus attention on new issues, from research commercialisation to engagement with the wider public.

Policy innovation happens primarily through project rather than block funding. For example, although most member states have made public commitments to promote a significant increase in the volume and content of university-industry collaboration, this has generally been addressed through programme or project funding rather than institutional funding. For example, already in the 1990s Sweden added the 'third task' of cooperating with society to the University Law, but made no provision to reflect this in basic funding. There are exceptions to this general rule of thumb, for example, with the UK adopting something of a hybrid strategy where in addition to block and project funding, the government has begun to use *institutional* project funding to correct or transform certain qualities in the wider system. This model has been used repeatedly during the past decade in area of university industry links, and in 2008, the Higher Education Innovation Fund (HEIF3) had a budget of around EUR 100 million and provided institution and institution-project support to consolidate 'third stream' activity across the higher education sector. This hybrid model has been used for the correction of backlogs of investment in research infrastructure and for the engagement of the wider public in research.

A consequence of the focus on competitive funding instruments is that the proportion of universities' research income deriving from the block grant has tended to fall. The Swedish Higher Education Authority points out that in 2006, the block grant provided only 46% of Swedish universities' research income. In the UK, the split between institutional and block funding has been inverted during the course of the past 20 years, where block funding accounted for more than 60% of all government funding of research in higher education, that figure was around 40% in 2007/08. In Ireland a new system is in place and although there is a large block grant, a portion of this institutional fund (up to 10%) will in the future be performance related and linked to strategies and outcomes.

Increasing the ratio of project-based to block funding is an explicit policy objective in countries where little use has so far been made of project-based funding. France has set a target of

4 Governance of Public Research: Towards Better Practices, Paris: OECD, 2003

increasing the proportion of project-based funding from almost nothing in 2005 to 20% by 2010. Cyprus' Strategic Plan for Science and Research 2004-6 similarly seeks an increase in competitive funding, to be channelled through the Research Promotion Foundation. The Czech National Innovation Policy 2005-2010 aims to change the ratio of block to project funding from 60/40 to 40/60. Slovakia has been increasing the proportion of research funds distributed under competition in the past few years, and has reached 25%.

4.5 Institutional autonomy

At the level of the research performers, the transformation of universities into independent entities is one of the most important reforms, as seen in Austria, Denmark[5], Italy, Portugal, Spain, Slovakia and Lithuania for example. This process is still very much a work in progress, with several member states still to implement these reforms.

As an example of this kind of reform, in 2007, France passed a law aimed at granting more autonomy to French universities (adopted by the French parliament on 1 August 2007), which will structure the reform of higher education over the next five years, and aims to:

- Grant universities more autonomy to decide their budget and staff, allowing universities to create foundations to collect money and put in place their own recruitment processes;
- Give universities more competence in opening their administration to external staff, allowing for example representatives of the business world to take part in university governance;
- Strengthen the state's legal control.

There has been a gradual transition in the new Member States from 100% state ownership of all research structures towards a more mixed system. Traditionally the Academies played a strong role in the new Member States and were highly regulated, however new laws have been introduced to change this structure.

In the case of applied research institutes, there has been widespread agencification and marketisation, in order to make more explicit the basis of the relationship between principal (state) and agent (institute). In practice, this means that a majority of public research institutes operate in a more or less open market place, providing research and technology services to government clients plural, with this work subject to a time-limited contract and clear performance criteria. It also means that there is increasing competition among research performers seeking to secure and satisfy government demand for research services, competition which extends across the public and private sectors, and even internationally.

This increasing autonomy means that national policy can be defined to a greater extent in line with anticipated future needs, rather than past investment and forward commitments to research performers. In turn, research performers must become more strategic in order to continue to prosper.

5 There is a move to integrate the Research Institutions in Denmark into the Universities.

4.6 Institutional governance and leadership

In order to escape the lock-ins caused by traditional, academic-dominated governance structures and to orient universities more towards the needs of society, there has been a slow process of reforming the leadership structure of universities in some countries – moving towards the UK / US model where the head (vice chancellor or president) of the university is both the head of the faculty and of the administration.

The Netherlands university law of 1997, sub-titled the 'modernisation of the university governing structure' (the MUB), abolished the principle of 'co-management' and replaced it with 'participation' by the members of the university in management. It changed the balance of power in this direction. Several Danish universities are using the greater freedom they were given by the 2003 reform in order to set up executive managements. Recent reforms in Austria and Spain shift decision-making authority towards the rector and middle management and away from the academic committees. However, the UK model remains the most 'managerialist' of those used in Europe.

There has also been a trend towards involving external stakeholders in university governance, typically with the state (or sometimes, the universities themselves) appointing people from other parts of society onto the university council (or other oversight committees). The objective here is to bring a greater sense of urgency to proceedings and to provide champions able to debate proposed reforms with academic leaders.

There are two broad models for appointing the leadership, in particular the rector, president or vice-chancellor (depending on local terminology). Traditionally, in continental Europe the faculty has elected rectors either directly or by using the senate or another senior academic body as an electoral college. This is currently the case in 18 member states plus Flanders. In an increasing number of countries, however, it is the Council that appoints the head of the university. This means that academic views are factored by those of external stakeholders, whereupon the 'chief executive officer' is more likely to have proven strategic and administrative competencies as well as scientific. Austria and Denmark moved from more traditional election systems in 2003 and Luxembourg more recently chose the managerial model for its first university. The UK, Netherlands (since 1997), Sweden and Lithuania also operate in this way.

Scientific research institutes, especially the academies, have tended to be strongly self-governing and there is little evidence of change in this respect. As in the universities, those institutes staffed by civil servants are changing the status of their employees to normal private contracts. Applied research institutes tend, on the other hand, to be managed much more like companies, which is not surprising, given that they are exposed to markets in a significant proportion of their activities. Their personnel have more flexible employment conditions, often including an element of performance-related pay. Applied research institute managers can by and large manage like private company leaders.

4.7 Human resources management

Institutional autonomy is eroding such central coordination, however national authorities are still very influential in many countries where, for instance, salaries are a result of national negotiations or independent national wage tribunals. In some cases, government might determine the number of staff and the payment scales. Indeed, in Southern Europe, university researchers often have civil servant status.

In some countries institutional responsibility for human resource policies coincides with attempts to strengthen the attractiveness of higher education and research as a career and as a workplace. Attracting the best people into public research is an issue which hinges not just on allowing mobility of human capital, but also on attracting individuals into the sector in the first place and making sure their knowledge is retained. There is a focus on issues pertaining to the employment status of staff and the lack of a career structure for researchers within universities. Most European countries face similar challenges in that post-doctoral careers are characterised by low salaries, a lack of employment rights and stability.

The introduction of performance related pay is a new development. In Germany this has now been stipulated nationally and all HEI pay professors on performance related basis and in a more market orientated way. The salary of professors now consists of a basic income and performance based supplements, which are negotiated individually between the central management and the professor. Some Irish HEIs are beginning to pay on performance related basis and in a more market orientated way. National salary levels are negotiated in a social partnership model between HEI and academic trade unions. In the UK, universities are autonomous employers. They determine staffing levels; decisions on this topic are often taken on the faculty level within clear institutional policy guidelines. HR policies are debated and approved by the governing body. The market for academics, especially for “star performers”, became increasingly competitive. Therefore flexible reward and retention schemes became more important. Hungary and Denmark are also looking at increasing pay levels to help attract staff, but this does not include a switch to performance related pay.

5 - Recent activities

5.1 Performance contracts

Governments are not withdrawing from their responsibility or influence for the public research base but are using new methods of steering the research base to align with policy priorities. A handful of countries have followed the New Public Management approach of writing performance contracts with the universities. Some regions in both Spain and Germany have done so for a time. Austria, France and Denmark have all introduced performance contracts since 2003. In the Austrian case, 20% of the income from the Education Ministry is dependent upon the performance indicators specified in the contract.

In Germany the first performance contracts were signed between the government of Baden-Wurttemberg, Berlin and Lower Saxony with universities. Since then, this kind of instrument has been introduced or is in preparation in all German States.[6] In Spain, regional governments such as Catalonia have developed pluri-annual programme-contracts with public universities since 1997. Public funding is then provided according to progress in the area chosen. Specific objectives are established in the research and technology-transfer, relations with the society and university management areas. In research and technology-knowledge transfer, the objectives can concern the achievement of internationally competitive science, technology and innovation systems. The contracts signed in Catalonia represented additional funding of €720 million over the 1997-2001 period.

Performance contracts are used increasingly in connection with applied institutes' core funding. GTS, Denmark, Austrian Research Centres, the Flemish institutes and VTT Finland are all steered via performance contracts, and it is planned to move the Swedish institutes to such a system in the future. In France, the 'contractualisation' of relations with the universities was paralleled by setting a performance contract with CNRS. As with the universities, however, it is not clear that there is a strong feedback loop from performance against contract to the amount of state money the institutes get.

5.2 Evaluation and quality control

Member states report a growing interest in performance monitoring and evaluation, which is a corollary of the increasing autonomy of public research institutions and a need for budget holders to be able to demonstrate efficient and productive use of public funds. Several countries have created new institutions external to the universities with a quality control mission, including

- In 2007, France created the Evaluation Agency for Higher Education and Research (AERES)
- Italy passed a law in 2006 to set up a new National Research and University Assessment agency (ANVUR)
- Lithuania's Centre for Quality Assessment in Higher Education has a remit that covers not only education but also research

6 See K. König et al, Vertragliche Hochschulsteuerung, Institut für Hochschulforschung Wittenberg, October 2004, www.hof.uni-hall.de/steuerung/zv/uebersicht.htm And evanat: Informationsprotal qualitätsmangement an deutschen Hochschulen, http://evanet.his.de

- In the Netherlands, university quality control is mostly handled internally by the universities, but they are supported by Quality Assurance Netherlands Universities (QANU) in research as well as education
- A range of institutions in Spain, including the Centre for the Development of Industrial Technology (CDTI), the National Agency for Evaluation and Prospective studies (ANEP) and the National Commission for the Evaluation of Research Activity (CNEI)

The research quality control system that stands out as distinctly different is the UK's Research Assessment Exercise (RAE), which has been in place since 1986. It has evolved over time, however it uses a combination of bibliometrics and international peer review to assess and rate the research of every university department in the country (that chooses to submit). The resulting ratings are used to allocate around 30% of the national science budget across the period until the next RAE. Most importantly, the funding credits are heavily skewed in favour of the best performing departments and as a result the stronger research universities have seen substantial growth in their research income in the period, while those universities with a weaker research base have seen their income shrink.

The goal was to drive up the quality of research and to bring about a degree of concentration of research performance, both of which have been achieved. Having established the principles and practice of performance-related income, the UK government has decided to simplify the RAE, placing more weight on bibliometric analyses. Outside the UK, there has been little enthusiasm for this type of quality control or such a strong feedback loop from evaluation results to resource allocation. An exception is Denmark, where a similar exercise that will influence the allocation of the block grant for research is planned to start in 2008.

5.3 International research cooperation

A growing number of European member states has published national policies to promote and facilitate international research cooperation, and in particular to increase and strengthen links to leading scientific nations and emerging economies outside the EU. The motivation is as much to do with international relations and access to rapidly developing markets as it is about science. However, increasing international engagement is seen to be a part of the reform agenda, and a means by which to improve both research quality and relevance.

There is a growing strategic interest in the subject at the university and institute level too, and this is rather more than business as usual. International relationships are coming to be seen as a vital means by which to drive research excellence, attract students and staff and sustain the institution in the longer term. There are regional-level initiatives too (sub-national), where public bodies – often economic development agencies – are pursuing a range of policies to promote and facilitate the international engagement of local universities and research institutes, both to help to boost inward foreign direct investment of technology rich, high productivity foreign affiliates and to facilitate outward facing relationships and exports.

5.4 Industry engagement in research

Increased interaction between universities and industry is a long-standing policy objective in all Member States and many have long-running programmes that promote both 'pair wise' research cooperation between companies and universities as well as the formation of more extensive networks to facilitate diffusion and valorisation.

There is evidence of renewed efforts to promote industry engagement and not simply through project level cooperation, but relationships through for example the direct engagement of the private sector in the governance and leadership of universities is and the encouragement of strategic research partnerships with individual companies.

Industry engagement has been integral to the reform agenda and the subject is tackled in some detail in Part C of this paper, and elaborated rather more fully in Annex C.

6 - Trends and implications

6.1 Trends

The principal trends evident as regards member state policies on research reform are post-legislative policy measures to press forward with greater levels of institutional autonomy within the university sector. Reform is very much a work in progress, however.

There appears to be a reduction in the level of prescription and direct management of the university sector by the state, although there is growing policy interest in university performance, and related efforts to incentivise increasing excellence and connections to social and economic end games.

Similarly, there is evidence of a reduction in the extent to which policies and priorities are decided by academics alone. Other stakeholders are playing a more prominent role, albeit typically working with an academic majority.

With the drive towards autonomy, MS appear to have few active policies to promote improved terms of employment and careers for researchers. Conditions of employment differ markedly too, with a broad split between MS where university researchers are to all intents and purposes civil servants with protected posts (jobs for life), pensions and other benefits and those where a majority of researchers are not tenured, but must work within the context of successive short-term contracts linked to specific grants.

While institutional reform is much in evidence, few MS are pursuing active policies to rationalise the shape and size of the public research system, and even where these are in evidence, it is not clear they have been particularly successful.

There is clear evolution in research funding models, with many member states beginning to increase project funding relative to institution funding, and in some cases linking institutional funding to objective reviews of past performance. There has been an extension of research funding instruments with new measures to reinforce legislative changes and to help to secure policy objectives, and in particular with respect to newer commitments from innovation to public engagement.

On balance, the process of reform appears to be rather uneven, with a minority of MS that have arrived at a situation where their public research organisations are independent, internationally competitive research organisations, alive to changing research priorities, but with broadly based funding sources and flows of students and faculty from around the globe.

6.2 Implications for ERA

This gradual and uneven approach to research reform in Europe suggests that there is an important and continuing role for the European Research Area, through more and better information sharing about reform and research and experimentation with aspects of reform

In terms of more and better information, member state policy makers and scientific leaders might be galvanised into pursuing reform more quickly and more completely by

- The publication of an annual report presenting a map of progress on the key dimensions of research reform, showing the state of the ERA on the one hand and highlighting recent changes on the other. This kind of factual account might be both reassuring and encouraging
- The preparation and publication of more complete evidence base as regards the extent of the process of reform, the nature of this reform and the impact reform has had on the size and health of the research base in each member state
- Support for increased debate on the risks and rewards of reform across member states, involving policy makers, intermediary organisations and the institutions themselves, and possibly using these same networks as a platform for more operational work with information exchange and sharing of knowledge as regards the practicable solutions

Research reform will require more than the new ERA Communication and a commitment to increasing information sharing. There are many issues where further research and experimentation might be helpful, and those questions might include any of the following

- What kinds of funding models are most likely to strike a balance between socio-economic impact (relevance) and international standing (research quality)?
- What kinds of governance structures are most effective
- What does leadership and professional management mean in a public research setting?
- What more might be done to secure business engagement in the definition of research policy and the governance of research institutions
- What more might be done to encourage / facilitate institutions to work more closely together, and on a global stage?
- What more might be done to improve the conditions and career prospects for researchers?

Part B - International research cooperation

7 - Introduction

Part B concerns international research cooperation policies of the EU member states and in particular intra-EU research cooperation. The first section presents an overview of the status of knowledge as regards international research cooperation in general. Intra-EU research cooperation is presented in the section following, selectively drawing out aspects of EU member state policies or measures that stand apart in some way from the mainstream position on international cooperation. Later sections pick out recent activities and discuss trends and policy implications for ERA.

8 - Overview

8.1 The drivers of collaboration

In many EU member states, policy makers' interest in international research cooperation tends to be a mixture of ideas and motivations, which are a product of the intrinsic nature of research itself as well as a multiplicity of external factors.

There are perhaps three drivers that relate to the nature of research itself

- Research is a global undertaking. Policy makers encourage / permit individual researchers to maintain geographically extensive social networks, because it is received wisdom that this both motivates researchers and strengthens research performance
- Research can require a scale and intensity that few if any individual governments can underwrite (indivisibility). Policy makers subscribe to and promote participation in dedicated international programmes and networks, where these exist and are judged to be beneficial to national research priorities, whether for reasons of critical mass (e.g. cosmology) or affordability (large-scale facilities) or financial opportunity (access to third-party funds)
- Research is an excellent platform for wider policy ambitions. Policy makers sign international agreements and launch programmes to facilitate cooperation with non-national researchers where this is deemed helpful to their wider strategic interests nationally, whether political or economic

The sociology of science, and knowledge production more generally, is perhaps the most fundamental driver of international research cooperation. It is a foundation of the academic profession that research excellence demands an international context, with breakthroughs building on the work of our predecessors and shaped by debate with one's collaborators and adversaries across the global community. Throughout their career, professional researchers strive to build and renew their social networks in order to validate their work, enhance their knowledge and advance their personal interests.

In practical terms, the scale and geographical extent of the public-sector research base means that the frontier of knowledge, in almost any field or discipline, will be determined in some degree at least by people and institutions in countries other than one's own.

While one might contend that some disciplines are more global than others, so theoretical physics perhaps has more extensive international networks working on fewer questions as compared with those researchers working in the area of applied linguistics, and that researchers resident in larger scientific nations, the US, Japan, Germany, are more likely to be able to rely on domestic networks to derive the excitement, insight and incentive necessary to excel, the notion of research as a global undertaking is pervasive and strengthening.

From a policy perspective, this means governments and scientific administrations tend to want to facilitate what is an organic, bottom-up process, sometimes even preferring simply to keep out of the way, while at other times seeking to ensure that policies and instruments do not have any features that might unintentionally dissuade or impede domestic researchers from forming and exploiting global social networks on an ad hoc basis.

This policy position is in flux however, with the historical 'hands off' approach increasingly being replaced by a hybrid approach that combines a more strategic view with the more established concern to ensure the best conditions for international research cooperation. This evolution can be seen to be part of the wider reform agenda, with policy makers, research administrations and institutions striving to make research budgets work harder.

In terms of external drivers, one can see perhaps five broad challenges that will tend to increase the amount of international research cooperation:

- Globalisation of the world's economies, and in particular the shifting economic balance of power from west to east, and an appeal to science to square the circle;
- Low growth rates and tightening public finances across the OECD, with a growing expectation that public research must deliver increased social value;
- Technological factors, from the internet to grid computing to regional aircraft, which have tended to shrink the world we live in;
- Socio-cultural factors as regards trust and accountability and the interplay of different ideologies, and the emergence of the global citizen; and
- Other global pressures and potential shocks with the potential to affect all of us rather than some of us, from climate change to pandemics to poverty in sub-Saharan Africa.

Overall, this tends to mean that national policy makers have a broadly similar set of objectives for international research activities, which is:

- Making all domestic research more international in outlook and connectedness;
- Making best use of existing, dedicated international schemes;
- Making strategic use of research in the international arena; and
- Fulfilling one's science-based obligations to the international community.

The drivers of intra-EU research cooperation can be taken from this general menu of policy motives and objectives, with the principal differences being the relative importance given to regional cohesion and the existence of a supra-national research policy pursued through a supra-national research budget, which dwarfs other regional or international programmes, typically by several orders of magnitude.

8.2 The benefits of international collaboration

From the perspective of national policy makers, the kinds of benefits sought from a more strategic and proactive approach to international research cooperation might include:

- A demonstrable improvement in the international rating of the national research base, or the maintenance of one's position for those countries and regions at the top of the international league tables;
- A more effective / productive research and innovation system; and
- A stronger and bigger economy.

For universities and research institutions, the benefits sought from taking a more strategic approach to the promotion, management and facilitation of international research cooperation tend to revolve around the organisation's international standing and its vitality and sustainability as a centre of excellence in the longer term.[7]

For individual researchers, the benefits sought from a conscious decision to devote a greater part of one's time to international work are an improved ability to contribute to advances in understanding on the one hand and improved visibility and reputation on the other, both of which can contribute to professional and financial gains.[8]

While there is a general consensus that international relationships are integral to good research, there is little material in the public domain that helps to dimension the sorts of benefits realised through international collaboration, and its added value over a more narrowly national or regional approach.

Exhibit 2 Relative average impact of national papers and those co-authored with other countries (2001-2005), by broad discipline

	Clinical	Health	Biological Sciences	Environment	Mathematics	Physical Sciences	Engineering
UK (Total)	1.21	1.37	1.42	1.29	1.20	1.33	1.12
UK + USA	2.33	2.66	2.40	2.09	1.56	2.25	1.71
UK + FRANCE	2.61	3.00	2.20	2.00	1.39	1.86	1.80
UK + GERMANY	2.33	2.99	2.24	1.94	1.70	1.90	1.75
UK + CHINA	1.77	1.44	1.67	1.10	0.81	1.20	0.91
USA (Total)	1.32	1.45	1.43	1.29	1.32	1.55	1.33
USA + UK	2.33	2.66	2.40	2.09	1.56	2.25	1.71
USA + FRANCE	2.59	3.65	2.31	2.17	1.84	1.99	1.83
USA + GERMANY	2.16	3.02	2.24	2.15	1.64	2.02	1.89
USA + CHINA	1.30	1.13	1.22	1.18	1.29	1.34	1.16
FRANCE (Total)	1.12	1.05	1.17	1.22	1.13	1.11	1.14
FRANCE + UK	2.61	3.00	2.20	2.00	1.39	1.86	1.80
FRANCE + USA	2.59	3.65	2.31	2.17	1.84	1.99	1.83
FRANCE + GERMANY	2.93	4.14	2.38	2.09	1.40	1.64	1.58

7 A survey of UK universities' vice chancellors and pro-vice chancellors found a widespread commitment to pursue international research cooperation in a more strategic and proactive fashion (+90%). International Research Collaboration, a Universities UK briefing note prepared by Technopolis limited (February 2008).

8 While success and longevity in international collaboration might depend critically upon an open, equitable and reciprocal relationship, few people or institutions enter into such relationships for purely philanthropic reasons. In most cases, the parties will have their own needs and goals in mind.

FRANCE + CHINA	3.13	1.53	2.86	1.77	1.12	1.64	1.55
GERMANY (Total)	1.11	1.19	1.28	1.28	1.10	1.26	1.31
GERMANY + UK	2.33	2.99	2.24	1.94	1.70	1.90	1.75
GERMANY + USA	2.16	3.02	2.24	2.15	1.64	2.02	1.89
GERMANY + FRANCE	2.93	4.14	2.38	2.09	1.40	1.64	1.58
GERMANY + CHINA	2.10	0.80	1.73	1.21	1.25	1.51	1.39
CHINA (Total)	0.73	0.62	0.55	0.71	0.85	0.66	0.78
CHINA + UK	1.77	1.44	1.67	1.10	0.81	1.20	0.91
CHINA + USA	1.30	1.13	1.22	1.18	1.29	1.34	1.16
CHINA + FRANCE	3.13	1.53	2.86	1.77	1.12	1.64	1.55
CHINA + GERMANY	2.10	0.80	1.73	1.21	1.25	1.51	1.39

Source: Adams et al, 2007, Patterns of International Collaboration, using Thomson ISI data

Research quality is the one dimension where analysts have tried to identify and test the benefits / outcomes of international collaboration, and recent data suggest there is a very significant gain in terms of research quality and impact, as revealed by academic citations. Exhibit 2 compares the average 'impact' of national research papers with international papers by selected broad discipline, for the UK and its key competitor countries. In the case of the UK for example, the table shows an impact rating of 1.21 for domestic clinical sciences papers as compared with an impact rating of 2.61 for 'international' papers with at authors resident in the UK and France. The international gain over the average figure for national papers is the same for almost every country pairing and discipline, which suggests that international papers will tend to be published in higher impact journals and attract more citations than do their national counterparts.[9]

This general truism founders on the specific rocks that are the impact scores for China, which include numerous examples of international collaborative output achieving lower impact than the domestic-only papers. This holds for all partner countries. In an extreme case, the USA sees lower than national impact in every field in which it collaborates with China. For the EU MS included, the greatest differences appear to be around clinical and biological sciences, in particular with France, Germany and the UK.

The table suggests that research collaborations can be motivated by strategic aspirations rather than by excellent science per se, with leading researchers seemingly being prepared to trade access to potential future opportunities in return for training/knowledge transfer today. The data also suggests that China is managing to pursue discipline-specific partnerships with those countries where it has most to learn. The *Evidence Limited* study (2007) notes that China's 'preferred' partners in any field seem to be the nations that have higher research impact in those fields, for example the UK in biomedicine.

One might imagine similar bibliometric analyses helping to unpick the kinds of research gains produced for all MS and disciplines through participation in the EU RTD Framework Programme, however such an exercise would be a major undertaking in its own right.

9 These data do not amount to definitive proof that international collaboration produces stronger research. It might very well do so, however there are a number of important bibliometric features that will tend to distort / re-calibrate familiar indicators. Most obviously, with say four authors, the bibliometric databases will record four publication counts not four quarters of a single count, as such the number of authors influences the output indicator directly. Moreover, with multiple authors, a paper is likely to have more promoters, giving talks and self-citing, which in turn can increase visibility and amplify subsequent citations by other authors.

8.3 Modes of international cooperation

International research cooperation appears in many guises, from the ad hoc writing of joint papers that arise out of informal contacts at international events to fixed-term visiting fellowships at overseas institutions to cross-border collaborative research to the creation and operation of international joint research centres.

Exhibit 3 provides an overview of the results obtained from an earlier research cooperation mapping study by Technopolis, when respondents were asked to list, in order of strategic importance, the main forms of international engagement activity undertaken by their organisation. The share of respondents indicating that they have undertaken each form of activity during the last three years is shown, along with the average ranking of each activity in terms of its strategic importance to the organisations concerned. Lower numbers indicate a higher ranking and hence higher importance. 10

Participation in collaborative research projects is by far the most prevalent form of international activity, cited by 88% of the respondents. The study also found that a majority of organisations rate international research collaboration as being the most important of all of their international engagement activities.

The next most prevalent forms of international engagement are the recruitment of scientists and engineers, cited by half (49%) of the organisations in the sample. The hosting of overseas students on postgraduate training courses (27%), organisation and attendance at conferences and seminars (24%), and the sale or purchase of contract research services (20%), are the next most widely cited forms of activity. Further analysis of the data revealed that over 90% of organisations participate in more than one of the forms of activity listed, and a quarter (25%) are engaged in four or more different types of activity.

Exhibit 3 International Engagement Activities (n=137)

	Share of respondents	Importance rank
Joint conduct/publishing of research		
Participation in collaborative R&D projects	88%	1.9
Utilising/accessing international facilities	9%	2.9
Co-publication in international journals	4%	2.3
Permanent relocation of resources		
Recruitment of scientists/engineers	49%	3.0
Establishing a physical presence/centre overseas	12%	2.5
Monitoring/Sharing/Influencing		
Attending/organising conferences/seminars	24%	3.0
Memberships of committees, panels, journal boards	13%	3.3
Networking (Formal)	5%	1.8
International trading in research		
Sale and/or purchase of research services	20%	2.8
Sale and/or purchase IP/licences/technology	7%	3.2
Temporary relocation of resources		
Inward flow of foreign students	27%	2.2
Temporary outward training	14%	3.7
Exchange of personnel	13%	3.0

10 An average score of 1.0 indicates that all respondents ranked that barrier first on importance.

8.4 Intergovernmental research cooperation

While the great majority of international research collaboration is informal, ad hoc and driven bottom up, there are numerous instances of MS level agreements and collaborations, albeit the number of instances falls off dramatically as one moves from the small and informal to the large and complex legally binding joint ventures involving governments.

Most European member states maintain tens of bilateral intergovernmental research agreements with other European countries, which often provide a framework within which the informal, researcher driven collaborations, numbering in their thousands, operate.

Bilateral international cooperation agreements are in widespread use throughout the EU member states, however only one study has sought to map these agreements in any detail.[11] While it was carried out in 2000, these intergovernmental level agreements change only slowly and the work remains a useful indication as the nature and extent of collaboration.

Exhibit 4 Number of bilateral R&D agreements, EU Member State – World Regions (June 2000)

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	UK	TOTAL EU
Other Europe	18	22	3	0	23	28	8	2	19	0	5	2	22	1	17	170
Ex-USSR	7	6	3	1	5	9	3	0	8	0	2	0	5	1	14	64
Africa	4	2	0	0	24	20	0	0	14	0	1	4	10	0	6	85
Asia	10	14	0	3	22	54	1	0	14	0	6	2	3	3	26	158
N. America	3	5	0	1	9	54	0	1	4	0	0	4	3	1	7	92
S. America	1	18	0	0	26	23	0	0	10	0	0	4	28	0	4	114
Australasia	1	0	0	0	6	6	0	1	2	0	2	0	0	1	1	20
Total exc. EU	44	67	6	5	115	194	12	4	71	0	16	16	71	7	75	**703**
EU	18	14	3	4	52	46	11	10	16	0	16	16	41	12	31	**290**
TOTAL	**62**	**81**	**9**	**9**	**167**	**240**	**23**	**14**	**87**	**0**	**32**	**32**	**112**	**19**	**106**	**993**
% exc-EU	71	83	67	56	69	81	52	29	82	0	50	50	63	37	71	71
% EU	29	17	33	44	31	19	48	71	18	0	50	50	37	63	29	29

Source: Technopolis survey of national research administrations, 2000.

This framework for collaboration is most developed in France, Germany and Spain, which each maintain more than 40 EU-EU bilateral agreement, where 10-15 might be more typical, and with perhaps as many as 500 agreements in total for all EU MS together (EU-to-EU agreements only).

In addition to bilateral agreements, the EU has an impressive track record in the creation of major scientific and technological facilities, based in *multilateral* inter-governmental research agreements. Many of these multilateral agreements are linked to specific research and technology institutions or programmes, and are motivated by a desire to manage the economic implications of the commitment to be at the forefront of advances in a broad spectrum of research domains, often dual use, from space to particle physics to molecular biology.

DG Research and the European high-level committee on science and technology (CREST) both commissioned EU-wide studies to map this form of international research cooperation, however those studies were completed more than seven years ago and while the list of organisations is recognisable, their memberships have changed dramatically in the period as a result of first European enlargement and second globalisation more generally. In addition, there have been

11 Bilateral International R&D Co-operation Policies of the EU15 Member States,' carried out by Technopolis for DG Research (2000).

major new agreements / facilities agreed in the interim, such as the Global Biodiversity Information Facility (GBIF) and ITER[12] and even the Global Monitoring for Environment and Security (GMES) project, as well as new EU-wide strategies expressed through for example the European Strategic Forum for Research Infrastructure (ESFRI) roadmap.

Its is perhaps sufficient to note that most MS are members of each of Europe's major multilateral research schemes from the European Space Agency (ESA) to the Institut Laue-Langevin (ILL), and which together more than match the EU RTD Framework Programme, in budgetary terms, investing EUR 5-7 billion a year, with as much as 50% of this figure for the associated domestic budgets that support researchers' participation in the science being performed in laboratories at the European Centre for Nuclear Research (CERN) and the European Molecular Biology Laboratory (EMBL) for example.

8.5 The extent of researcher-level collaboration

In order to gauge the extent of international research collaboration, it is typical to make use of one of a very small number of specialist science and technology statistics. The most common technique is co-publication analysis, a form of bibliometric analysis that involves counting the number of academic journal articles with authors with addresses in two or more countries.[13]

Available bibliometric data suggest that international papers account for 20-40% of all domestic research output, as well as showing strong long-run growth in international research cooperation for most leading scientific nations, with the trend being positive in both absolute terms and as a share of all research activity and output.

Exhibit 5 presents three linked tables showing figures for the numbers of international research articles published in each of the last two, 5-year periods.[14] The first two tables present the basic counts for each period. The third table presents the growth in output across the two periods. The first two tables show the counts for a series of eight partner countries and a residual figure for papers written with authors based at addresses somewhere in the rest of the world (ROW), which together sum to the total number of international papers recorded by the Thomson ISI web of science database.

Exhibit 5 International collaborative research output by country and partner country, 1996-2000 and 2001-2005 (number of articles) and for growth across the two periods (%)

1996-2000	Total	UK	USA	CAN	FRA	GER	JAP	AUS	CHI	IND	ROW
USA	244,911	30,874		28,754	20,744	32,095	23,711	10,679	9,226	4,555	84,273
GERMANY	106,821	13,490	32,095	4,136	11,863		5,485	2,729	2,754	1,713	32,556
UK	97,592		30,874	6,138	11,114	13,490	4,988	6,039	2,838	1,369	20,742
FRANCE	82,076	11,114	20,744	4,791		11,863	3,119	1,772	1,351	1,036	26,286
CANADA	55,429	6,138	28,754		4,791	4,136	3,069	2,433	1,801	627	3,680
JAPAN	54,346	4,988	23,711	3,069	3,119	5,485		1,986	3,915	1,076	6,997
AUSTRALIA	30,743	6,039	10,679	2,433	1,772	2,729	1,986		1,463	391	3,251
CHINA	25,836	2,838	9,226	1,801	1,351	2,754	3,915	1,463		404	2,084

12 ITER is a joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power. The partners in the project - the ITER Parties - are the European Union (represented by EURATOM), Japan, the People´s Republic of China, India, the Republic of Korea, the Russian Federation and the USA. ITER will be constructed in Europe, at Cadarache in the South of France.

13 A second analytical technique makes use of patent data in order to count the number of patents with inventors from two or more countries. Where bibliometrics is particularly good at indicating academic collaboration, co-invention analysis is rather better at showing business-to-business relationships, however the co-invention statistics published annually by the OECD are too aggregate to be of any great use to our efforts to map technological collaboration between the European member states.

14 The tables are derived from data presented in Patterns of International Collaboration for the UK and leading partners (summary report), Adams, Gurney and Marshall, June 2007 (Evidence Limited).

2001-2005	Total	UK	USA	CAN	FRA	GER	JAP	AUS	CHI	IND	ROW
USA	334,662	43,337		38,913	27,135	43,921	31,148	15,999	20,542	7,021	106,646
GERMANY	146,615	20,235	43,921	6,464	16,609		7,464	4,388	5,401	3,101	39,032
UK	144,457		43,337	9,248	15,502	20,235	6,658	9,573	5,505	2,253	32,146
FRANCE	107,729	15,502	27,135	6,423		16,609	4,646	2,753	2,774	1,530	30,357
JAPAN	77,197	6,658	31,148	3,933	4,646	7,464		2,964	8,631	2,262	9,491
CANADA	75,659	9,248	38,913		6,423	6,464	3,933	3,672	3,688	981	2,337
CHINA	54,529	5,505	20,542	3,688	2,774	5,401	8,631	3,663		1,127	3,198
AUSTRALIA	46,502	9,573	15,999	3,672	2,753	4,388	2,964		3,663	776	2,714

Growth	Ave	UK	USA	CAN	FRA	GER	JAP	AUS	CHI	IND	ROW
USA	148%			135%	131%	137%	131%	150%	**223%**	154%	127%
GERMANY	153%						136%	161%	196%	181%	120%
UK	154%		140%	151%	139%	150%	133%	159%	194%	165%	155%
FRANCE	146%					140%	149%	155%	**205%**	148%	115%
JAPAN	155%							149%	**220%**	**210%**	136%
CANADA	142%				134%	156%	128%	151%	**205%**	156%	64%
CHINA	214%									**279%**	153%
AUSTRALIA	162%								**250%**	198%	83%

Source: Adams et al, 2007b, based on Thomson ISI publications data

The dominance of the US is immediately clear, accounting for 25-51% of each country's international collaborations, and ranked first for all countries except France. The other feature that comes through in this analysis is the importance of collaborations with the 'rest of the world' for the US, France and Germany and the much more concentrated bilateral connections evident in the case of Australia, Canada and China. Between the two periods, China has increased its ranking by one or two places for six out of the seven partner countries. In line with this movement for China, the other countries have all seen a fall in their ranking in at least one case, except India, which was ranked 9th for all countries in both 5-year periods.

Exhibit 6 Count of China's S&T output and its collaborations with its major S&T partner countries (2005 publications, count of papers, %)

China ISI statistics (2005)		
China total ISI articles	59543	
China collaborative output	17751	
China partner countries collaborative papers		**% of total China collaborative output**
US	5791	33%
Japan	2222	13%
UK	1561	9%
Germany	1381	8%
Canada	1109	6%
Australia	974	5%
France	827	5%
Singapore	726	4%
Korea	646	4%

The bibliometric data are largely insensitive to the nature of the inputs or collaborative activity. They help us to understand that there is a strong structural element to international research collaboration, with smaller leading scientific nations tending to exhibit higher levels of international research cooperation as compared with the larger ones, so Sweden and Switzerland outperform the USA and Japan by a factor of two in proportionate terms.

In disciplinary terms, physics papers tend to involve much larger numbers of authors than do engineering or maths papers, and as such, physics records much higher levels of 'international output.' Within this big picture, it appears that there is a general upward trend in collaboration,

which is consistent across countries and disciplines, and it also appears that rapid growth in China is a major contributory factor for growth in collaboration everywhere.

8.6 Intra-EU collaboration

The motives and policies associated with intra-EU research collaboration echo those of international research collaboration in general, although there is a stronger focus on regional cohesion and international relations than is the case for international links more generally.

In terms of patterns of collaboration, a majority of these intra-EU cooperations are entered into with immediate neighbours and those close by in cross-border regions.

France and Germany appear to be the most active proponents of intra-EU cooperation, with wide-ranging agreements with most European member states, and with the geographical mix extending in line with European enlargement. This proactive position is evident in the distribution of counts of intra-EU bilateral research agreements. France and Germany are also the two member states where public policy statements are openly committed to helping to deliver on the objectives of the European Research Area.

The forms of collaboration appear broadly similar too, with a predominance of researcher mobility and joint seminars and symposia. However, within this broadly similar picture, joint research is more in evidence, which perhaps the existence of the EU RTD Framework Programme, which while small relative to total European public expenditure on research, is many times larger than any individual member state's international research budgets and in particular, has the depth of pockets to fund large-scale, long-term collaborative research projects involving many parties from many countries.

EU RTD FP has been a very important feature of the research landscape for the past 20 years, and as such the Commission Services and EU researchers have a track record in strategic, large-scale international research cooperation that is arguably absent almost anywhere else in the world. For smaller member states and in particular the new member states, the EU RTD FP has been a hugely important source of additional funds nationally, and a source of uplift for quality at the national level, through the use of competitive calls and through the association with research groups in other countries. It has also been a source of learning about how to collaborate across borders, and work well within large, geographically distributed and multi-stakeholder consortia. In this sense, intra-EU collaboration has been fundamental to research reform and the promulgation of the ERA.

In several member states, such as Germany and the UK, there is an explicit separation of the policy lead and administration between international research cooperation in Europe, and beyond. This is driven by differences in funding and critically by the fact that EU member states are paying tens if not hundreds of millions of euros each year, through membership subscriptions and other budgetary appropriations, into half-a-dozen EU-level programmes, and most notably the EU RTD Framework Programme. Securing a proportionate share of those EU budgets is a major undertaking, with target income often approaching the scale of a small national research council.

8.7 Intra-EU research agreements and schemes

8.7.1 German cooperation with CE Europe

Poland, Hungary, the Czech Republic, the Slovakian Republic and Slovenia are important partners in both bilateral and European cooperation, and have been throughout the period before they joined the EU. Memoranda on the future shaping of cooperation in education and research were signed with Estonia, Latvia and Lithuania in 2003. The development of cooperation with Rumania and Bulgaria is also making good progress.

Key areas of cooperation include the stimulation and networking of regional innovation initiatives along the lines of the German research and education ministry (BMBF) Inno-Regio Programme and its follow-up programmes, "Innovative regional growth centres" and "Interregional alliances", as well as the wide spectrum of funding measures for innovations in small and medium-sized companies. Apart from holding bi- and multi-lateral meetings of experts, workshops and conferences, the BMBF also supports targeted preparatory measures in order to stimulate cooperation between innovative regions in Germany and the partner countries and to establish interregional cooperation.

Key areas of bilateral cooperation with the accession countries are in the field of the neurosciences, genomics and proteomics, new materials, the physical and chemical technologies, biotechnology, environmental research and technology, health research, information technologies and production technologies.

One example of regional cooperation is transport research whose significance is growing against the background of EU expansion. Following the signing of a Memorandum of Understanding with Poland and Hungary in the field of transport logistics at the instigation of the BMBF, an international workshop on securing mobility, held in Dresden in September 2003, gave important stimulus to transport research. Research focuses on two areas: "Cross-border problems" of the sustainable development of mobility in the new European regions and "Universal problems of mobility" arising from processes of structural change in towns, regions and conurbations.

Cooperation with Croatia, Serbia-Montenegro, Macedonia, Bosnia-Herzegovina and Albania focuses on the political, economic and social stabilisation of the region and its integration in the European Union; these five South East European countries have the status of potential accession countries. Croatia has already applied to be included in the negotiations for accession to the EU. The Joint Declaration of the Heads of State and Government of the EU Countries and the Western Balkan States was signed at the EU-Western Balkans Summit in Thessaloniki on 21 June 2003. It stresses the special role of science and technology for the region's political and economic stabilisation and points out that the future of this area lies within the EU.

The main areas of the BMBF's cooperation with these five states are support for the process of stabilisation and leading South East Europe into the European Education and Research Area. Instruments for this purpose are bilateral activities as well as multi-lateral and regional events, such as for example joint workshops, counselling projects and information and cooperation events of a preparatory nature.

Principal fields of work and research are information and communication technologies as well as research and innovation policy. Furthermore, the BMBF supports the efforts of the partner countries in representing their interests with regard to European funding programmes before the EU Commission and playing an active part in such programmes. This establishes important foundations for future bilateral cooperation with partners in South East Europe and for their involvement in European structures.

8.7.2 Franco-German research collaboration

France is Germany's most important partner among the EU member states. Intensive cooperative relations are maintained in numerous fields and at different levels: between the ministries, between scientific and research organizations, and in the form of specific projects.

Since the 40th anniversary of the Elysée Contract in 2003, the Research Ministers of both countries have been agreeing on joint work programmes in the area of research and innovation, which are known as 'feuilles de route'.[15] They are updated at the Joint Councils of Ministers, which take place twice a year. In these work programmes, short- and medium-term cooperation objectives are defined for selected research fields that have a high priority for both countries.

The current work programme includes activities in the following areas:

- Institutional cooperation of research organisations;
- Innovation policy;
- Cancer research;
- Genome research (with a focus on the genetic causes of rare diseases);
- Plant genome research;
- Animal genome research; and
- Marine Research.

8.7.3 Franco-Polish research collaboration

Poland has several longstanding collaborative research agreements with various EU countries, designed to ensure the country's leading researchers are connected to frontier research in areas of particular national strength.

France is Poland's third scientific partner behind the US and Germany while Poland is the National Centre for Scientific Research's (CNRS) most important partner in Central Europe. Joint publications with CNRS constitute 60% of Franco-Polish co-publications and the friendship between their research teams is strengthened by numerous collaborative projects.

The Polish Academy of Sciences (Polska Akademia Nauk - PAN) is still very much at the heart of Polish research. Created in 1952, this self-governing corporation of 500 eminent scientists and scholars oversees national research and employs 4500 researchers in 81 research institutes, almost all devoted to fundamental research.

CNRS and PAN began collaborating in 1957. This cooperation has developed into a mutually beneficial relationship, anchored by more than 300 exchange projects and 52 structured bilateral and multilateral programmes since 1990. The partnership has produced numerous results in all scientific disciplines, most notably in nuclear physics, particle physics, and chemistry. 23 joint publications have appeared in two of the most prestigious and selective journals, Nature and Science, in the last 20 years. CNRS has also launched 52 cooperation programmes of its own to structure this collaboration, in addition to its participation in the ongoing state-sponsored Franco-Polish cooperation programme, Polonium. These include six international programmes for scientific cooperation (PICS), three-year projects between a CNRS lab and a partner abroad, which span the

15 January 22, 2003 marked the 40th anniversary of the Treaty of Elysée, also known as the Franco-German Treaty, and one of the basic documents governing the modern relationship between these two member states. It was signed by General de Gaulle, then President of the French Republic and Dr Konrad Adenauer, then Chancellor of the German Federal Republic. The treaty, under Article 2, para. 1, binds France and Germany to "consult before any decision on all important questions of foreign policy and, in the first place, on questions of common interest, with a view to reaching as far as possible an analogous position."

fields of engineering, nuclear physics, and social science. Among these are proposals for the installation of the ICARE detector in Warsaw, the study of solid-state spectroscopy and the mechanic and thermodynamic properties of materials, as well as the spin manipulation in semiconductor nanostructures.

Three Associated European Laboratories (LEA) have also been set up with Poland. LEAs are "labs without walls" that associate several CNRS teams and a foreign partner over a period of four years. The first one specialised in the molecular and macromolecular chemistry of transition metals, the second in the study of nitride optoelectronic devices, and the third in new astrophysical theories.

Lastly, ten multilateral research networks complete this partnership. These structures link public or private labs in two or more countries for a period of four years to facilitate mobility, information exchange, and the organisation of conferences and workshops. In this way, Poland contributes to a variety of research areas, including the study of the genome of paramecium, renewable energies, the development of cancer, atmospheric science in near-Earth space, and the history of present times.

All in all, the collaboration with CNRS is a strong indicator of Poland's exemplary integration into the Europe of science, one that seems to be constantly gaining momentum.

8.7.4 Poland-Norway fund for research

In 2007, Norway and Poland launched a €15 million research fund to boost academic cooperation between the two countries. The fund, which is supported with a €13 million grant from the Norwegian commitment to a European Economic Area (EEA) development programme[16] and €2 million from the Polish government, will provide grants to joint Polish-Norwegian research projects and support workshops and seminars facilitating research cooperation between the two countries.

The fund, which aims to strengthen the cooperation between Polish and Norwegian researchers, will focus on environmental and health research. Health-related topics slated for support include epidemiology, ageing, cancer, innovative medicines, health services research and telemedicine. In the environment field, issues of interest include environmental management, biological diversity, optimisation of the use of natural resources, arctic research, energy and water scarcity.

A first call for proposals was announced in autumn 2007, and it is expected that around eight research projects will receive funding of up to €2 million each. The projects are to be led by Polish principal investigators. In addition to this, 70 smaller grants will be given to support bilateral workshops or seminars designed to facilitate cooperation and networking between Norwegian and Polish researchers, and strengthen their joint success in other programmes, and especially FP7

The Polish Information Processing Centre is taking the lead role in managing the fund, with the support of the Norwegian Research Council. Proposals are judged by a team of external referees on quality and importance, with the final decision being taken by the Board of the Fund.

8.7.5 Nordforsk

NordForsk was established on January 1st 2005 as an independent Nordic research board operating under the Nordic Council of Ministers for Education and Research (NMR). NordForsk and its activities are funded by the Nordic countries through the budget of the NMR and through the participation of national research funding bodies in specific ventures. NordForsk has its secretariat in

16 Norway is a signatory to an EEA development scheme that aims to reduce social and economic disparities within the European Economic Area (EEA), and to enable all EEA countries to participate fully in the Internal Market.

Oslo and a Board consisting of members appointed on an institutional basis connected to their central positions in the national/Nordic research system.

The mission of NordForsk is to strengthen and further develop the Nordic region as one of the most dynamic regions in the world for research and innovation and, thereby, enhance the international competitiveness of the Nordic countries and the living conditions of the populations in the region. It performs three basic duties: Co-ordination, financing and policy advice. Notwithstanding its small size, the Board seeks to pursue international research cooperation, within the Nordic region and beyond, in a manner comparable with the largest and most progressive European national research councils, addressing the spectrum of policy goals and using a full complement of research funding instruments. It coordinates research priorities that have been identified as suitable for joint Nordic efforts, concentrating on research areas where the Nordic countries have an international position of strength.

The overarching objective for NordForsk's coordinating activities is to develop the Nordic Research and Innovation Area (NORIA) as a globally leading and attractive region for research and innovation, inspired by the rhetoric of the ERA.

NordForsk uses the full complement of funding instruments in its efforts to create synergies that build on existing, significant national investments in research, and

- Networks of centres of excellence
- Researcher networks
- Collaborative research programmes
- Researcher mobility
- Researcher training

The policy advice role involves NordForsk acting as an advisory body to the Nordic Council of Ministers in the field of research.

In addition to the promotion of cooperation within the Nordic area, NordForsk has the ambition to pursue its mission on a more extensive basis

- It will consider supporting research collaboration with the three Baltic countries and North West Russia, in line with the Nordic Council's policy
- The European arena is important in many ways. The activities of NordForsk should enable researchers to successfully apply for European funding and prepare Nordic actors for the EU 7th Framework Programme.
- It intends to develop partnerships with other European actors such as the European Science Foundation (ESF) and the European Research Council (ERC), partly to hope to shape agendas and partly to prepare Nordic researchers to succeed in calls for proposals

In the longer-term the board has plans to develop activities related to the Northern Dimension and to promote collaboration with (i) strong research nations, (ii) emerging growth economies, and (iii) with developing countries.

9 - Recent activities

9.1 MS internationalisation policies

International cooperation is an increasingly fashionable topic and in a recent survey, a CREST working group found that 1o of the 22 European countries that responded to its survey already had an international research strategy of sorts, albeit often amounting to a section in a broader national research strategy or where the strategy dealt with internationalisation more specifically, covering issues relating to both higher education *and* research.[17] Eight of the remaining 12 countries responding stated that they are in the process of developing a national strategy focused on internationalisation of S&T.

- Finland, France, Norway, Portugal, Sweden, Turkey and the UK have an explicit internationalisation strategy
- Denmark, Estonia and Romania have addressed this as part of a broader strategy
- Austria, Germany, Greece, Ireland, Malta, Netherlands, Portugal and Spain all reported that they were in the process of developing an international S&T strategy

Just four countries indicated that they neither have nor plan to have a national strategy on internationalisation of S&T (Cyprus, Czech Republic, Lithuania and Liechtenstein).

The reasons for the four countries that do not have and that are not developing any internationalisation strategy in the field of S&T are diverse: in the case of Liechtenstein and Lithuania they are related to limiting structural issues of their own national research and innovation systems. In the Czech Republic, the development of a specific policy is simply not in the work programme although the national strategy for research and development 2004-2008 does make passing reference to the importance of international cooperation. Meanwhile, Cyprus reports that it is content with its existing arrangements, and particularly its access to the EU RTD Framework Programme, and does not see a pressing need to develop a national strategy as some kind of superstructure.

The CREST study and supporting policy documents suggest MS are pursuing a range of policy measures

- Many MS - new strategies on internationalisation of domestic research
- Some - seeking to mainstream INCO in domestic programmes
- Most - new international R&D agreements with third countries
- Majority - programmes to promote, broker and report back on INCO
- Many - new programmes to sustain / expand INWARD mobility
- Some - new programmes to attract leading researchers from abroad
- Some - funds to support international centres / projects
- Majority - most new MS INCO initiatives are very small

17 Survey of EU member states' senior science and technology officials carried out on behalf of the CREST working group on internationalisation of R&D, July 2007

9.2 Public consultation on future of ERA

The report of the public consultation on the future of ERA suggests that MS see intra-EU research cooperation as an important force for change and institutional strengthening, however it is one which reinforces national-level reform initiatives, set against the backdrop of bottom-up competition amongst research groups around research excellence.[18]

Several MS support aspects of increased European connectedness, with Sweden going as far as to suggest that it would explore supporting the development of a number of *European* universities. Others anticipate building on existing networks and centres of excellence, national or pan-European. Belgium proposing an increase in Community funding for Networks of Excellence or their successor, Spain favours the creation of European Centre of Excellence *label* to reward and encourage existing national successes and Turkey supports the notion of virtual networks extending beyond Europe. Ireland and Switzerland consider the value of virtual networks unproven, and a matter for further investigation. A synthesis of the main points is presented in the boxed section below.

Strengthening research institutions: Member State' Positions

MS see action in this area as very largely a matter for the national and local levels. Austria has found that moving towards more autonomy is a fundamental cultural change that will happen gradually. Spain has recently passed a law giving more autonomy to its universities.

Estonia emphasises the importance of sustainable funding for institutions. Germany and Switzerland consider funding based on excellence and autonomy of research institutions to be crucial.

The Netherlands suggests that the ERA will primarily develop if MS make the financing of national research institutions more competitive. The UK considers that there would be benefits of comparability and compatibility between national systems, with the Bologna process as a model. Poland would also wish to learn from the experiences of non-European countries as well.

Belgium sees critical mass as key for institutions and wants to see universities and research centres merge and specialise with more Community funding for Networks of Excellence. Spain favours the creation of a "European Centre of Excellence" label built on the experience of existing national exercises. Ireland wants to limit further proposals for European centres of excellence (real and virtual) until current initiatives have been assessed. Turkey agrees with the creation of "virtual research communities" by pooling and integrating activities and resources from different locations and disciplines within and beyond Europe.

18 Commission Staff Working Document: 'Results of the public consultation on the green paper, "European Research Area: New Perspectives." Brussels, April 2008, SEC(2008) 430. The other principal source of data on intra-EU research cooperation is the descriptions of agreements, schemes and activities provided on the web sites of national research administrations and agencies.

Switzerland considers the added value of virtual centres unproven. Germany considers that in order to be successful, the networking of research institutions to form centres of excellence must be developed on the initiative of the institutions.

Sweden would explore supporting the development of a number of comprehensive, research-intensive, world-class universities at European level. Switzerland would support a European university ranking established by the EU. Finland emphasises the importance of links between research institutions and industry. Finland does not support the idea of developing common principles for the funding and assessment of research institutions because of the different types of mission performed by different research institutions.

Overall the *public* consultation was strongly in favour of continuing with the natural and incremental change, with people arguing that diversity of systems and institutions might be a competitive advantage for Europe, rather than a weakness. Equally, stakeholders see strengthening being a matter for bottom-up initiatives in the main, albeit with more and stronger partnerships with industry and society with appropriate critical mass, based on scientific excellence. Successful public-private partnerships should develop in a "bottom-up way" and on a voluntary basis. The bureaucratic requirement is principally around the need for increased funding and to define incentives that ensure the quality of the bottom-up initiatives, to share good practices and experiences, and to ensure funding allocation on a competitive basis.

10 - Trends and implications for ERA

10.1 Trends

In Northern Europe, MS do single out internationalisation in a more general sense as an important mechanism for conditioning domestic research, and are issuing national policy documents and creating new funds and measures that promote this position. MS are seeking to secure the long-run health of domestic research through competition and collaboration, endorsing the global view of knowledge production on the one hand, and the need for specialisation, with the need to influence international research priorities and access international labour markets on the other.

A significant trend is the extension and globalisation of MS research policy, with the focus moving beyond Europe to new strategic partners, notably China and India. Future trade relationships and emerging scientific prowess are becoming more important determinants of the shape of collaboration. In addition to extending geography, there is an ambition to do more than promote domestic interests, with a public commitment to contribute significantly where possible to a variety of emerging global challenges, from climate change to poverty.

MS are increasingly competing with one another for the attention of the world's leading researchers, as well as with their counterparts in other parts of the world, from Australia to Japan to the US.

MS policies and strategies do address the subject of intra-EU research cooperation, however not necessarily from a reform perspective. These strategies suggest the EU RTD Framework Programme will continue to be a dominant feature of international engagement for most MS, underpinning the numerical dominance of intra-EU links within all international cooperations. Most MS international strategies devote a section to Community level initiatives, with a primary focus on securing a greater share of future funds for domestic researchers, and doing more to influence and align programme content with national priorities. There is interest too in research infrastructure and the options for doing more at a European level. Lastly, there is support in principle for optimising MS programmes, in search of synergy and economies, through bottom-up collaboration, delivered through light-touch, variable geometry mechanisms such as those funded through the ERA-NET scheme.[19]

19 The objective of the ERA-NET (European Research Area Networks) scheme is to step up the cooperation and coordination of research activities carried out at national or regional level in the Member States and Associated States through: the networking of research activities conducted at national or regional level, and the mutual opening of national and regional research programmes. The former is more prevalent than the latter.

10.2 Implications for ERA

Intra-EU research cooperation clearly has a role to play in the future of research reform and institutional strengthening at the level of individual MS, and one can see several possible implications for the future of ERA.

There would be value in further work to extend and develop the available evidence base, to reveal patterns, trends and impacts of international research cooperation in general and intra-EU cooperation in particular.

The EU RTD Framework Programme already provides substantial and significant support for intra-EU collaboration, and its broadening mechanisms appear to align well with MS policy makers' ambitions to internationalise their domestic research base further still, including:

- The provision of funds to pay for research cooperation with scientists and engineers in third countries, where most MS provide quite limited funds for such international engagement, and much of it is restricted to mobility rather than research proper;
- The extension of European fellowship programmes to include candidates resident in other parts of the world, as a means by which to increase the attractiveness of the EU to the European 'scientific diaspora' and the best non-EU talent;
- The financing of key infrastructure in line with the European Strategy Forum on Research Infrastructure (ESFRI),[20] and particularly support for international flagship projects, from ITER[21] to the Large Hadron Collider (LHC) where non-European countries have been significant sponsors;
- The development of EU-wide strategies in challenging areas from next-generation large-scale research infrastructure to policy research in areas ranging from energy security to public health to climate change;
- The promotion and possible financing of joint programmes, which bring together interested member states to jointly fund research and demonstration projects in pursuit of common objectives, such as policy research

Through Framework, Europe has more experience of doing international research collaboration than anyone else, and there is almost certainly a great deal of know how and guidance that might be of practical use to member states seeking to improve the efficiency and value added of their own programmes. This could be relevant to MS international schemes, however it is likely to be most valuable to national programmes seeking to develop a stronger international base (international projects), whether that is agreements to avoid double jeopardy or models of international research centres.

20 ESFRI is intended to develop scientific integration within Europe. Its mission is to support a strategic approach to policy-making on research infrastructures in Europe, and to facilitate multilateral initiatives leading to the better use and development of research infrastructures, at EU and international level. The publication of the first Roadmap for pan-European research infrastructures in 2006 was something of a landmark, and several projects are now entering the realisation phase. An updated roadmap is due to be published in 2008.

21 ITER is an experimental reactor that will be built in the south of France to reproduce the physical reaction - fusion - that occurs in the sun and stars. Existing experiments have already shown that it is possible to replicate this process on Earth. ITER aims to do this at a scale and in conditions that will demonstrate the technological feasibility of fusion as an energy source. It involves substantial support from non-European countries, including significant funding from China.

Part C - Industry engagement

11 - Introduction

This section of the report presents an analysis of industry engagement in the definition and implementation of university-based research, and in particular the changing role of the private sector within the leadership of technical universities. The subject is elaborated through the description and consideration of the policies and practices in three case study member states and universities: the University of Manchester in the UK, the University of Twente in the Netherlands and the University of Vienna in Austria.

12 - Overview

12.1 MS policy situation

Each of the three member states has what amounts to a published national strategy that is committed to increasing industrial engagement in public-sector research. In all three cases, national strategies view industry engagement from a number of perspectives, and in particular as an increasingly important financier of research carried out within public sector and a channel through which to exploit the know how and intellectual capital being produced.

Each member state explains this commitment to increased engagement in a similar vein, stating that success will bring significant domestic benefits and a step change in the social rate of return to public R&D expenditure, without compromising scholarly freedom and quality.

While industry engagement is clearly not a simple and universal force for 'good,' that all member states and all institutions must embrace, there are at least some data to suggest that consideration of use should not result automatically in a debasement of public research and the wider social endeavour. UK government monitoring reports suggest that the quality and international standing of its research output has been increasing steadily throughout the past decade, and in parallel with this growing policy commitment to strategic research, research commercialisation and industry engagement.

Success is expected to follow from some or all of the following lines of reform

- Industry influence over the scope of research being performed, with an improved alignment between a member state's portfolio of research and its strategic requirements and international comparative advantage
- More and better connections between knowledge producers and users (and the more appropriate education of graduates / post-graduates), wherein consideration of use will become endemic, thereby increasing the proportion of all research investment that produces meaningful economic or social outcomes
- Increased share of total research income originating in the private sector, reinforced by trends such as open innovation, and which will help to combat the dual challenge of tightening public finances and the rising cost of research

Commentators expect industry engagement to change the culture of public research, and to develop institutions' capacity to manage IP to a successful conclusion.

12.2 Forms of industry engagement

In principle, business engages with public research institutions through one or more of the following six strands

- Recruitment of researchers
    a. Students, staff, placements and secondees
- Purchase of research outputs
    b. Purchase of researcher's time
    c. Purchase of time on research facilities
    d. Purchase of licences / payment of royalties
- Strategic research partnerships
    e. Collaborative research projects
    f. Co-financing of technology centres
- Appointments of business people to governing bodies and senior posts
    g. Chairs / members of institutional governing bodies
    h. Rector, vice rector or other senior officer
    i. Chairs / members of working groups
- 'Privatisation' of elements of research delivery system
    j. Outsourcing of key functions to private-sector specialists, from managing incubators / labs to providing mentoring for startups
    k. Private sector models of human resource management
    l. Asset management of endowment and other funds
- Endowments given to research institutions

Strategic research partnerships

Strategic research partnerships are another point of engagement between universities and private companies, which while it is not about university leadership in a strict sense, does appear to be a growing and influential trend.

The three case studies include some notable examples of major corporations, from global technology companies to national retailers, joining HEIs as partners and joint shareholders of new initiatives, whether that is a major new on-campus technology centre or an international joint venture to launch a new educational programme.

Appointments to governing bodies and senior posts

In all three case studies, the university in question is increasing the involvement of people with a business background in its governing and executive bodies, encompassing both education and research. This is most advanced in Manchester and Twente, where, by contrast, academic and political appointments are still in the majority in Vienna.

The case studies illustrate three ways in which the private sector might engage directly with the leadership of an institution, which is through the appointment of people with a commercial background to:

1. The position of president / rector or other senior university officer;
2. The university's governing body or its standing advisory committees from finance to audit; and
3. Ad hoc working groups convened to inform institutional strategy on topical issues from curriculum development to knowledge transfer.

Private sector appointments can also extend to support with high-level operations like fundraising. US universities, for example, have made great play of the creation of voluntary funding committees

often led and populated by successful business people, able to support the work of the senior management team in pursuit of funding and wide-ranging, productive external relationships.

Privatisation of elements of the research delivery system

Adoption of private sector models of human resource management is well advanced in some countries, which in the UK for example has meant moving away from national pay scales to variable market prices, which at the most senior levels is an international labour market with prices determined globally through competition with other leading institutions and the private sector. A vice chancellor or president at a world class research university like Imperial College in London for example might command EUR 0.5 million in terms of a total package, comprising salary, pension and bonus. One can see this trend at lower levels too, with new posts being created for directors of research commercialisation for example and with remuneration packages on the order of EUR 100K.

One can see this private-sector influence extending to leadership training and mentoring, with the top universities sending rectors on courses to Harvard or putting them through coaching programmes and providing them with mentoring buddies. Private sector approaches are in evidence elsewhere too, in for example the management of IP portfolios or the investment philosophy and asset management of endowments.

There are examples of HEIs looking to specialist consultancies to help them do a better job of research commercialisation, outsourcing management of science parks and incubators for example or more narrowly running the technology transfer operation on a contracting and shared profits basis. These operational partnerships might be expected to extend to universities' research and technology services too, with business services companies providing the commercial front end (e.g. marketing, sales, client relationship management, etc) to a university's rather diffuse and more narrowly equipped academic staff.

13 - Recent activities

In Austria

The 2002 University Act brought radical changes to mission, autonomy and governance of Austrian universities, and opened the way for increased industry engagement in research and education.

In the recent past, this has resulted in the University of Vienna appointing several private sector people to the university board, the appointment of professional administrators with private sector backgrounds to critical posts, from finance to human resources and the creation of a series of private affiliates to implement the university's outreach work, from incubation to science parks to research contracting.

In addition to legislation, the Austrian government has launched a number of other policy initiatives to help to drive reform in the public research system in some general sense, and to strengthen links between industry and leading research groups specifically. The national programme of competence centres is perhaps the best example of this, where periodical competitions have launched a series of what amount to new research institutions targeting areas of strategic interest to the economy and combining public and private interests in the pursuit of technological advances and commercial innovation.

In the Netherlands

The Netherlands published a new national policy for research and education in November 2007, which placed renewed emphasis on social and economic benefits deriving from higher education. While research excellence is the primary focus, the new policy does target several generic

technologies and applications of strategic interest to Dutch business, and it also makes a public commitment to drive out increasing economic value from the investment.

At an organisational level, the new policy launched a new inter-ministerial body, the Knowledge and Innovation interdepartmental programme board, with an explicit brief to improve links between universities and business.

In addition the government continues to launch new user-oriented programmes and to renew its support for established strategic research partnerships, in particular the leading Technological Institutions. The National Innovation Platform was set up to explore good practice in knowledge transfer and exchange and to discuss and promote its ideas and findings with leading research institutes and businesses.

In December 2007, the government published a cabinet position paper on private endowments and the philanthropic funding of research, which is intended to encourage universities to devote more effort to securing funds through this route, as well as rehearsing various proposals for new fiscal measures to stimulate increasing endowments.

In the UK

In the UK, the national policy framework seeks to make a much more explicit link between public investment in research and the innovativeness and competitiveness of the wider economy. National policy on science and innovation has lead to the national research councils adopting a 'third mission,' to actively promote the use of research for explicit social and economic gain.

Dedicated national funds, such as the higher education innovation fund, have been created to support the development of research institutions' innovation capacity and to promote industry engagement more generally. The UK Higher Education Innovation Fund (HEIF) provides funding on a competitive basis amounting to several hundred millions of Euros a year, in order to help universities (and research institutes through a parallel fund) develop the infrastructure, competencies and capacity to optimise the commercial returns from research-derived IP.

The UK's numerous technology funds have been rationalised in a single collaborative research fund managed by a new national agency, the Technology Strategy Board. The new agency has a Board that is chaired and populated primarily by leading business people, which sets strategies for both societal challenges and emerging technologies. It works exclusively through public-private partnerships, whether in research and technological development, or innovation networks or through academic industrial placements.

The most recent policy paper, Innovation Nation, has launched a series of measures to encourage innovation including for example the creation of a new scheme to encourage government procurement as a means by which to drive innovation, the creation of a nationwide, regionally delivered proof of concept scheme and a commitment to double the number of knowledge transfer partnerships, linking business with universities through long-term graduate placements supervised by academics and focused on business development projects and innovation.

UK universities have undergone major reform in the preceding 10 years, and one can see continuing evolution in business engagement through annual statistics, which report progress on for example business involvement in governing bodies, contract research income and research commercialisation. Strategic partnerships between individual leading research universities and major companies, from the more conventional on-campus advanced technology centres associated with for example aerospace and electronics to more novel partnerships involving leading technology users in the retail and financial services sectors.

14 - Trends and implications

14.1 Trends

In all three cases, it is clear that the national policy and legal environment has evolved in the past 5-10 years and has become increasingly concerned to improve and increase industry engagement in public research. The Lisbon agenda has reinforced this trend, with universities at the forefront of national and regional initiatives to attract inward investment from leading global technology companies.

In all three cases, national research strategies are evolving into what might be called research and innovation strategies, where a commitment to deliver research excellence sits alongside a parallel commitment to increase the benefits to the national economy deriving from this significant public investment and social activity. In all three cases, there is evident involvement of the private sector in strategic planning exercises, as architects and consultees.

In all three cases, one can see increasing levels of industry engagement at the institution level in appointments to governing bodies, the involvement / consultation with private sector around university strategies, public-private strategic research partnerships and the outsourcing of key 'innovation' functions. Appointments to senior administrative posts are increasingly common, however private-sector appointments to the most senior posts are not much in evidence in the three cases in question. Clearly, there are examples of such appointments in other universities, such as that of Sir Richard Sykes, formerly rector of Imperial College in London, and previously Chief Executive and Chairman of GlaxoSmithKline, one of the world's largest pharmaceutical companies.

In the Netherlands, the Association of Universities in the Netherlands (VSNU) reports a doubling of research income from the private sector, in the 10-year period from the mid-1990s. In the UK case, similarly, monitoring data show long-run, year-on-year growth in private sector involvement across HE in governing bodies, co-publications, research income, licence income and so on.

These trends appear to be echoed in industrial research, with a growing commitment to open innovation on the one hand and a growing sense that international comparative advantage is no longer rooted in the close and proprietary control of basic technology.

14.2 Implications for ERA

Industry engagement is at the heart of MS reform agendas and policies to strengthen domestic research more generally, and it is a trend that appears to be diffusing and strengthening. This ambition fits closely with the Lisbon agenda and the economic objectives for the ERA.

MS policies combine principled exhortation with elements of structural reform in for example the rules on membership of the governing bodies of research universities and small, dedicated measures to encourage and part fund increasing collaboration, whether through national foresight programmes, joint research or research commercialisation.

Change on the ground is gradual however, with seemingly uneven development across the EU wherein countries such as the Netherlands and the UK are perhaps a decade in front of many other MS as regards the policy commitment to industry engagement in research. The limits to engagement are manifold, however two features stand out in particular, which is the primary focus of public research organisations on the advancement of knowledge, a mission that is at one point removed from business objectives, and secondly the fact that businesses' primary relationships

with public research is recruitment and the purchase of technical services, and not collaboration. Indeed, when it comes to innovation most businesses would expect to collaborate with other businesses, clients, suppliers even competitors, far more frequently than they do with the research base.

This is a process, and a question of degree. MS do not aim for every business to be working on collaborations with a variety of public sector researchers, nor do they expect every academic to have multiple industry partnerships.

Overall, the implication for ERA going forward is one of support and encouragement to MS, whether

- Leading by example, through the open and careful development of new measures such as the European Technology Institute and the evolution of support for business partnerships within existing measures such as the EU RTD Framework Programme;
- Strengthening the evidence base. Launch EU-wide policy studies and evaluations to explore the extent to which the extension of the public research mission ought to be possible without compromising the public research system, and to document the achievements of particular countries / policies. Explore feasibility of extending CIS coverage of business linkages with research performers, to improve evidence base and ability to monitor developments; and
- Facilitating learning and information exchange amongst MS. For example, compiling case material of successful examples of engagement, launching EU-wide initiatives to support cross-institutional learning, and to support debate across the MS as regards where and how to act, at the national level (legislation, framework conditions) and at the institutional level (good practice).