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INTRODUCTION

This report aims to contribute to the *ex ante* impact assessment exercise for the preparation of 2012 ERA, and it is specifically targeted at a policy audience. In formal terms, it is part of the ERAWATCH2 project *in support of the coherent development of research policies*, providing a horizontal analysis as a deliverable of *Work Package 1 on Monitoring and analysis of national policies* (D 1.4.6).

The central aim of this brief is to identify policy trends on national levels and across at all six ERA dimensions, the latter as set out by in the 2007 ERA Green Paper¹, namely:

1. *Towards a European Labour Market for Researchers*
2. *Modernising research organisations, in particular universities, with the aim to promote scientific excellence and effective knowledge sharing*
3. *Opening up and co-ordination of national research programmes*
4. *Building world-class infrastructures*
5. *Knowledge transfer*
6. *International Science & Technology cooperation.*

In particular, it sheds light on those national policy developments driven by EU/ERA level activity, and the relative importance of specific dimensions in the overall ERA framework from a national perspective.

In principle, ERA impacts (i.e. outcomes on national level) may be adverse or beneficial in nature from both national and EU level perspectives. They may be serendipitous as well as explicit in terms of the underlying policy rationales. For example, an adverse ERA impact could drive national policies to focus on ineffective instruments, for example, national knowledge transfer policies supported by structural funds within the context of systemic failure in the economy. Similarly, policy changes observed may occur due to other dominant national policy rationales, coinciding with the ones supporting ERA goals. Lastly, ERA impacts may be initially due to both "hard" and/or "soft" mechanisms, e.g., EU's financial incentive structures impacting on national policy adjustments and/or diffusion of national best-practice by EU level information exchange and joint learning exercises among MS, respectively.

This work is based on two main sources of information: the 2010 ERAWATCH Analytical country reports and the responses to a questionnaire circulated among the ERAWATCH

¹ European Commission (2007), Green Paper on The European Research Area: New Perspectives', COM(2007) 161 final

country experts (section 1.1 elaborates on this in greater detail). The report covers the 27 EU MS clustered in 4 four country groups according to their innovation performance.²

Nevertheless, it should be regarded as *complementary* in terms of topic coverage to the series of reports and policy briefs prepared by the European Commission's Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS). These include: the *Progress in ERA Policy Implementation Report 2011*³ report focusing, on opening up and researcher mobility; ERAWATCH policy briefs such as *Research and Innovation Challenges and Policy Responses in Member States*⁴, e.g., highlighting, *inter alia*, grand challenges, smart fiscal consolidation and efficiency of public support in MS policies.

The current analysis focuses on Member State public policy efforts and does not provide an analysis of the activity shaping strategy at EU level, neither of the activity of public and private innovation actors and institutions on national and regional levels within the ERA domain.

Regarding the structure of this policy brief the second section presents qualitative evidence on policy trends for each country cluster and in each of the six dimensions of the ERA. We review and summarize this evidence with a particular focus on anecdotal evidence on ERA impact in MS policies in the third section, while the fourth section descriptively studies the relative importance of ERA dimensions. Bearing in mind insights from all these sections, we conclude this report with an attempt on EU/ERA policy implications.

Sources of information and methodological approach

This report takes as its main source of information the material prepared in the context of the EC's [ERAWATCH information platform](#) and the responses of selected independent country experts to a survey designed by IPTS. The analysis regarding the national participation in ERA-nets presented in section "Opening-up and Coordination of National programmes" builds on the information provided by the [NETWATCH platform](#), the EC's information platform on transnational R&D programme collaboration.

The main objective of the ERAWATCH Analytical Country Reports 2010 is to characterise and assess the evolution of the national policy mixes in the perspective of the Lisbon goals and of the 2020, post-Lisbon Strategy. Their assessments focus on the national R&D investments targets, the efficiency and effectiveness of national policies and investments into R&D, the articulation between research, education and innovation, and on the realisation and better governance of ERA. In particular, the 2010 country reports complement and update the policy assessment of the 2009 edition of the ERAWATCH country reports in the domains of

² Accordance between DG RTD.B1 and JRC-IPTS on objectives, focus and coverage for the final policy brief was reached at a Brussels meeting on 07/04/2011 (minutes summarizing the main points have been taken and circulated).

³ IPTS(2011), '*Progress in ERA Policy Implementation Report 2011*', by René van Bavel, Laura de Dominicis, Ana Fernández-Zubieta, Luisa Henriques and Fulvio Mulatero

⁴ IPTS (2011), draft policy brief on '*Research and Innovation Challenges and Policy Responses in Member States*', by Mariana Chioncel and Alexander Cuntz

human resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation.⁵

In a questionnaire/online survey developed by IPTS and sent out to the ERAWATCH country experts in spring 2011, they were asked to comment on, among others, barriers to researcher mobility, openness of science systems and funding, researchers' working conditions, national infrastructures, technology transfer, and, a general assessment of ERA from a national perspective.

With respect to methodology, the qualitative evidence on STI policy trends in the second section draws heavily on both sources of information mentioned above. In this way, we there begin the analysis by a synthesis of country reports for each country cluster and in each ERA dimension, as illustrated in the first appendix 'ex ante' stocktaking of country specific challenges and information on "Towards a European Labour Market for Researchers" among Innovation Leaders'. We further enrich this information collection by adding complementary information from expert surveys where relevant in specific dimensions. In the third section, we review the information gathered in the second, with particular focus on policy trends and adjustments in the context of ERA. In the following section, we then consider ERA assessment specific questions (and descriptive statistics based on these responses) from the survey among experts. In the last section, tentative policy implications are derived from the qualitative and quantitative stocktaking in all analytical chapters.

Country groups

Based on preliminary analysis results of the Innovation Union Scoreboard⁶, the EU Member States are clustered according to their average innovation performance assessed by 24 indicators, into performance groups:

- **Innovation leaders:** Denmark, Finland, Germany, Sweden which show a performance well above that of the EU27.

- **Innovation followers:** Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK which have a performance close to that of the EU27.

- **Moderate innovators:** Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain with a performance below that of the EU27.

- **Modest innovators** Bulgaria, Latvia, Lithuania and Romania having a performance well below that of the EU27.

Further details on methodology of the country clustering are provided in Annex 2

⁵ Council of the European Union (2008), 'Council conclusions on the definition of a "2020 Vision for the European Research Area"', 16767/08 RECH 410 COMPET 550.

⁶ PROINNO Europe (2010), 'The Innovation union's performance scoreboard for Research and Innovation', PROINNO Europe paper n°18, prepared by the Maastricht Economic and social Research and training centre on Innovation and Technology (UNU-MERIT) with the contribution of DG JRC G3 of the European Commission

SYNTHESIS ON THE SIX DIMENSIONS OF THE EUROPEAN RESEARCH AREA

TOWARDS A EUROPEAN LABOUR MARKET FOR RESEARCHERS

INNOVATION LEADERS

Denmark, Finland, Germany, Sweden all perform well above the EU27 average.

GEO/ TIME	R&D intensity (GERD as % of GDP)			Tertiary educational attainment			Employment in KIS sectors ⁷ (%)		HRST as a share of labor force			Salaries ⁸ (PPS)	Remuneration difference male-female (%)
	2007	2008	2009	2007	2008	2009	2007	2008	2007	2008	2009	2006	2006
EU 27	1,85	1,92	2,01	30	31,1	32,3	32,96	:	39,2	39,6	40,1	40126 ⁹	:
Denmark	2.58	2.87	3.02	42,5	45,4	48,1	43,51	43,91	48,8	52,3	51,8	43669	11
Germany	2.53	2.68	2.82	26,5	27,7	29,4	34,79	35,3	43,6	44	44,8	53358	27
Finland	3.47	3.72	3.96	47,3	45,7	45,9	40,73	41,06	49,6	50,1	50,7	36646	18.2
Sweden	3.4	3.7	3.62	41	42	43,9	47,83	:	48,7	49,3	49,6	47143	17.2

Source: EUROSTAT

• Stocks and mobility flows of researchers

The labour markets for researchers in Scandinavian countries feature similarities that cluster them together and to some extent differentiate from Germany. Finland and Sweden already exceed the 3% GERD target. The share of tertiary students, employment in KIS sectors and HRST as a share of labour force are significantly higher than the average EU 27 (while the share of tertiary graduates is lower in Germany). The private sectors show a high absorption capacity, as companies heavily invest in R&D. The rate of unemployment has generally increased during the crisis; however, the job perspectives rise with increasing level of education (lower unemployment rates for ISCED 5 and 6 graduates). In the Scandinavian countries, it has been of concern the decreasing number of S&T students and the potential shortage of highly-skilled professionals. This is generated by a range of factors, such as: high share of humanities and social sciences students, late entry into the labour market due to very generous students grants (as it is the case in Denmark); decrease of the absolute number of graduates (although the relative share remains stable) due to the demographic decrease

⁷ Share of total employment

⁸ Researchers salaries

⁹ EU25

(Finland). Therefore, the need to ensure a sufficient number of qualified S&T human resources is considered one of the key challenges. In order to maintain the high level of R&D and innovation activity in these countries, one option was considered the attraction of foreign researchers. However, in international comparison, in the Scandinavian countries, the levels of inward mobility of foreign professionals have been relatively low. The outflow of researchers and PhD students has been increasing in the recent years in Denmark and Sweden, but not in Finland (except the technical fields).¹⁰

Contrary to the low researchers flow levels showed by Scandinavian countries, Germany has a high brain migration. Germany with a share of about 12% of doctoral degrees taken by foreigners in 2005, underperforms when compared to UK (40%), but undertakes the Scandinavian countries. The researchers' inflow exceeds the outflow, Germany achieving the greatest "migration gain" from Russia, China, India and Poland. On the other side, Germany has the highest share among the foreign doctoral students in USA. The high number of nationals working abroad has raised lately concerns about brain drain, in particular to the US. In response to this concern, a specific scheme GAIN was established (in 2003) to support German scientists working in the USA to return to Germany. In order to enhance international mobility of researchers several programmes have been implemented, in particular by the German Academic Exchange Service (DAAD), the German Research Foundation (DFG), the Max Planck Society, the Alexander von Humboldt Foundation (AvH) and the Fulbright Commission.

In all the cluster countries, the barriers between public-private sectors are generally low and specific measures support the inter-sectoral mobility.

- **Providing attractive employment and working conditions**

The HEIs from all these countries are signatories of "The European Charter for Researchers" and "The Code of Conduct for the Recruitment of Researchers" and most of the issues covered by these initiatives are fully implemented, such as open and transparent recruitment and promotion. Nevertheless, besides these, other factors affect to a significant extent the ability of the labour market for researchers to attract young graduates.

By comparison with other European countries, the working conditions for researchers in all these countries are to some extent attractive, featuring specific advantages and disadvantages: a relatively flexible labour market, generally high remuneration levels and a relatively small salary gap between men and women. The Finish labour market seems to be the least attractive: the long term career opportunities are limited and the remuneration levels are lower than the EU average. On the other side, Denmark is a country with a flexible, mobile labour force, having a long tradition of long life training policies and funding schemes, which may explain the low levels of researchers outflow. In all the countries, there

¹⁰ The outflow of domestic teachers and researchers (long visits over 1 month) was 699 (741 in 2000). The inflow of foreign researchers and teachers to Finnish universities was 1,172 people (1,153 in 2000) in 2009. (Source: KOTA-database, 2010).

is some flexibility regarding the salaries, although to a large extent they are constrained by collective agreements (Scandinavian countries) or public salaries regulation (as is the case of Germany). Although in Germany and Scandinavian countries, the average annual salary for researchers exceeds the average EU-25, the remuneration levels are low compared to those paid by private enterprises. In addition, the rather rigid remuneration system in the public sector is considered inadequate for attracting excellent researchers. In Germany, the reform of the salaries of professors (2002) performance components that go beyond the stipulations of the “Tarifrecht” (public salaries regulation) were introduced. In addition, in Germany the academic career path follows a very rigid pattern, with low access to permanent positions, which triggered the high emigration levels, particularly to USA. In order to avoid the brain drain, measures like the career track for post-docs (Junior Professor) have been established.

In the Scandinavian countries publicly-funded stipends for researchers (including doctoral candidates) provide full social security coverage (sickness, maternity, unemployment benefit, pension), while in Germany only the maternity leave. Only in Sweden, the HEIs or publicly-funded research institutions contribute to large extent to the researcher supplementary pension schemes. The Swedish pension system is made up of two contributions: the Income Pension which comprises 18.5% of the salary and is paid monthly by the employer into the national pensions account and the Premium Pension (2.5%) to be invested into a fund of choice.

None of these countries have specific regulations that may hinder the career progression of female researchers. The project funding typically allows researchers to take maternal leave and to receive an extension of the contract after the maternity leave. Sweden has probably the most generous parental leave in Europe and has served as a model for many other countries. This is partly due to the fact that the social security system pays the parental benefit and not the employer. However, even in these countries there is evidence of a considerable loss of female research talent. Even in Sweden, a country with the reputation of high standards of gender equality, there are still major inequities between men and women: only a small percentage of high-level academic/management posts are occupied by women. The small number of females in the university management has drawn the attention of the Ombudsman for Equality in Finland and in 2011 the gender equality in universities is under specific monitoring. In Germany, although both men and women can take advantage of the parental leave, with a guarantee of workplace afterwards, the difficulties faced by young researchers when becoming parents are seen as key reasons for both a high percentage of childless researchers and women not realising their careers as researchers. Obstacles are for example the short term contracts, challenging amounts of working hours, required mobility, difficulties of “dual careers” and traditional social norms.

In all these countries, the state however introduced tailored measures for achieving a balance between working and family life such as flexibility schemes and the possibility work part-time. Positive discrimination measures are taken in Germany and Sweden. The "*Professorinnen programme*" provides funding for new permanent positions for female professors. Sweden is the only country that has national targets to ensure that there is gender balance for researchers at all levels, including managerial level, evaluation committee etc.

Also, Swedish HEIs may apply positive discrimination when recruiting staff. This means that when competing applicants have similar qualifications, preference may be given to applicants of the underrepresented sex.

- **Open recruitment and portability of grants**

Although only in Denmark and Germany there is a legal requirement which impose to some extent¹¹ to advertise internationally professorship positions, to a large extent all the research and academic positions are advertised internationally. There is no clear evidence of academic inbreeding in any of these countries, generally the open recruitment being regulated by laws or agreements. However, sometimes the job descriptions may favour internal candidates. In the HEI and publicly-funded Public research Organisations (PROs) generally transparent evaluation mechanisms for recruitment are implemented to a large extent.

The academic positions are in theory open to non-nationals. Generally EU/EEA citizens are eligible for these positions, while specific restrictions may exist for third countries researchers or additional facilities exist for some nationals (i.e. in Sweden, citizens of a Nordic country do not need a residence permit). In practice some barriers exist. For example the Academy of Finland research posts are open for foreign applicants but in this case the host university must agree to provide the research infrastructure for the applicant. However, the competition for permanent academic positions is high and most of the researchers' work is funded on project base. In Germany, the National Reform Programme 2008-2010 stipulates that the foreign nationals can be appointed as civil servant. No further information on the implementation status is given. Also with the implementation of the programme "*Labour Migration helping to ensure the adequate supply of skilled workers in Germany*" (July 2008) the barriers to the immigration of highly-qualified and highly-skilled professionals were removed. However, to some extent limitations exist: the academics labour market will be opened but a priority check must be performed prior to it ("Vorrangprüfung"), which first makes sure that no German researcher would be suited for the post. To increase the number of international researchers at German universities programmes for postdoctoral researchers, junior research group leaders, experienced researchers and internationally recognised professors (Humboldt Foundation, 2009).

The Scientific Visa package has been implemented in Germany and Sweden but not in Denmark and Finland. However in Demark, other schemes have been used to facilitate work entry (such as the high score for the PhD qualification required for the 'green-card' for access) and provide favourable tax conditions for foreign researchers. All the countries, except Finland have a system in place for the recognition of diploma.

A particular case is Finland, which has not implemented the scientific visa, neither has a system in place for the recognition of diploma. There is mainly one policy initiative to attract foreign researchers that provides funding on a competition base to projects recruiting highly merited scientists from abroad. These can be both foreigners and Finns living abroad.

¹¹ In Germany there is no corresponding legal requirement does not exist for public research institutions

Although, the new university law (2010) requires universities to be international, in practice this means that the recruitment strategies consider the international expertise an asset. Except some short term tax deductions, there are no other instruments to facilitate the immigration of foreign experts. An additional limitation for the foreign researchers is generated by the difficulties faced by the partners in getting a job (at least partly due to language issues). Although foreign researchers are not expected to be fluent in Finnish as English is widely spoken, in teaching this situation is often different as the permanent teaching staff is expected to be able to speak Finnish (and Swedish). Besides these issues specific for foreigners, the Finnish labour researchers market is not very attractive: the long term career opportunities are limited and the remuneration levels are lower than EU25 average.

With regards the portability of the grants, to a moderate extent the portability of the grants is implemented in Sweden, Denmark and Finland and to a small extent in Germany. The Swedish Research Council (VR) and Danish Councils of Independent Research participate in the European Heads of Research Councils (EUROHORCs) and signed the Money Follows Researcher (MFR) agreement. According to this agreement, a researcher moving to a country in which there is an organisation that has also signed the MFR agreement, can take along the remaining part of a grant. Project Research Grants and Research Equipment Grants are eligible. However, the researchers funded by the Danish Council for Strategic Research are not allowed to move the grant to another national HEI and PRO. In Finland, the portability of the grants is regulated by the rules of the funding institution; the grants awarded to the research organisation (HEI or PRI) are not portable, while those to individual researchers may be portable. Grants from Academy of Finland and Tekes are not typically portable. Some research funding organisations such as the German Research Foundation (DFG) offer schemes which enable the portability of grants to a certain extent. Alternatively scholarships are provided for shorter or longer stays abroad, for instance by the Alexander von Humboldt Foundation and the Max-Planck-Society.

In all these countries there is a balance between inward and outward mobility: low mobility levels, however increasing in Scandinavian countries and high levels of in/out flow in Germany. The Scandinavian countries, particularly Sweden and Denmark are increasingly opening up and encourage cross border mobility, while Finland for reasons that may be politically driven is more reluctant in implementing measures to support the international mobility. Overall, the features of the labour market for researcher and initiatives taken by these countries seemingly are driven by the national context and needs rather than by ERA requirements. The Scandinavian countries will face in the near future a shortage of highly skilled professionals; a sizeable inflow of foreign researchers was seen as an appropriate measure to respond to the labour force needs for the high R&D intense activity performed in these countries. In Germany, measures are taken to counterbalance the high migration of national researchers, particularly to USA. While Scandinavian researchers are not very mobile, probably also because generally they enjoy attractive working conditions, the inflows are also low, showing that the expressed concerns that Scandinavian may be reluctant in sharing their R&D facilities, opportunities to others may be grounded. In these countries, the

most important factor that trigger migration seem to be related to availability of permanent positions, and remuneration levels which although high they are not as competitive when compared to private sectors or USA.

INNOVATION FOLLOWERS

Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK perform close to the EU27 average.

GEO/TIME	R&D intensity (GERD as % of GDP)			Tertiary educational attainment			Employment in KIS sectors ¹² (%)		HRST as a share of labour force			Salaries ¹³ (PPS)	Remuneration difference male-female
	2007	2008	2009	2007	2008	2009	2007	2008	2007	2008	2009	2006	2006
EU 27	1,85	1,92	2,01	30	31,1	32,3	32,96	:	39,2	39,6	40,1	40126 ¹⁴	:
Austria	2,52	2,67	2,75	21,10	22,2	23,50	30,00	31,50	37,60	37,8	39,00	60530	30,40
Belgium	1,90	1,96	1,96	41,50	42,9	42,00	38,24	38,50	46,70	47	48,20	55998	32,35
Cyprus	0,44	0,42	0,46	46,20	47,1	44,70	29,20	29,32	42,50	43,7	43,00	50549	30,86
Estonia	1,10	1,29	1,42	33,30	34,1	35,90	27,84	28,16	44,40	44,2	45,60	21053	47,21
France	2,07	2,11	2,21	41,50	41,3	43,30	36,89	37,04	41,70	42,7	43,20	47550	22,63
Ireland	1,29	1,45	1,77	43,30	46,1	49,00	35,48	36,22	41,20	42,2	44,70	49654	28,27
Luxembourg	1,58	1,51	1,68	35,30	39,8	46,60	43,02	45,10	43,30	45,5	55,30	56268	23,86
Netherlands	1,81	1,76	1,84	36,40	40,2	40,50	42,71	42,66	49,80	50,5	50,90	56721	33,04
Slovenia	1,45	1,65	1,86	31,00	30,9	31,60	26,27	:	38,90	40,1	40,60	37970	15,29
UK	1,78	1,77	1,87	38,50	39,7	41,50	42,85	42,74	43,30	42,7	44,40	52776	25,59

Source: EUROSTAT

- **Stocks and mobility flows of researchers**

While most countries in the cluster have an R&D intensity below the EU average the share of HRST in the total labour force as well as the share of citizens in the age of 30-34 with tertiary educational attainment and KIS employment are higher as compared to average of other MS outside the cluster. This suggests a likely mismatch based on (good) supply but unfavourable demand conditions for STI human resources on national levels. One exception is Austria having both, higher R&D intensity and lower levels of HRST, the latter being partially compensated by higher quality levels of secondary education attainment and subsequent employment as technical support staff. Other exceptions are Estonia and Cyprus with comparatively lower rates of KIS employment due to their prevailing less R&D intense economic structures. However, with respect to inward and outward mobility performance and

¹² Share of total employment

¹³ Researchers salaries

¹⁴ EU25

among different researcher groups (students, doctorates, post-docs and senior scholars etc.) and under different mobility support schemes countries perform fairly different. In addition, centrally-collected, nation-wide data on mobility is scarce in country reports, in particular with respect to outward mobility flows, national inward-outward balances and due to the fact that a considerable share of flow-related activities is often being launched at the level of the individual research organization. As far as information on shares of foreigners in HRST (core definition) is available, these indicate an average rate between 15 to 20% in 2009, with Estonia and Cyprus underperforming at around 7% and Luxembourg with remarkable high levels 35%. Similar, but on weakly lower levels, holds for HRST shares of foreign-born researchers mostly accounting for about 15-20%, with the notable exceptions of Slovenia and, again, Luxembourg of around 8% and 37%, respectively. Often, barriers to inward mobility include, next to limited private and public demand and lower attractiveness of research labour markets, complicated legal procedures to get work and residence permits and national language (i.e. obligatory in teaching).

There is some evidence on inward mobility implying that foreign origin of HRST is likely to be correlated with geographical and cultural neighbouring countries, e.g., Austrian foreign-born researchers are frequently (next to German scientists) from surrounding former communist countries, or French, Belgian and German researchers being active in Luxembourg. The former aspect is highlighted by an increased mobility of researchers (in particular, outward related) in late accession countries such as Slovenia. However, some mobility patterns also suggest that extra-EU nationalities make up for almost one third up to half of non-national researchers in national domains of relatively more open science systems, e.g., researchers in Ireland originating from China, India and the US. Similarly, country and science system size seem to bias observed inward mobility patterns; smaller countries have either very high or very low shares of foreign-born HRST while medium and large countries rather range at medium levels around EU average. In some cases, notably Austria, inward mobility even is likely to compensate for HR demand-supply imbalances stemming from lower number of national graduates in S&T. In general, PhD and post-docs seem to be the most mobile among the overall group of researchers and face (as compared to the rest of the population) lower probabilities of unemployment, while foreign-held professorships are by far less frequent i.e. foreign shares decline with seniority and career advancement levels. One potential explanation is that international research experience and, hence, mobility has become obligatory standard in career terms of younger researchers and glass ceiling effects.

80% of the cluster's countries (according to country correspondent questionnaire) have implemented explicit policy schemes to attract foreign researchers, i.e. exceptions in the sample are Slovenia as well as the UK¹⁵. In particular, schemes are often addressing early stage scientists such as PhD or post-docs (more than senior scholars) and mostly do not

¹⁵ The UK has no or limited measures in place due to the excellence of its system in mobility terms as, e.g., already about 50% (40%) of Master students (of overall research staff) are non-UK nationals. Similar holds for foreign PhD students based in the UK. However, there is also an outflow of UK-educated people as the evidence suggests a large share resident in other OECD countries.

explicitly differentiate between attraction of EU and non-EU nationalities, however, they are likely to highlight the re-attraction of nationals working abroad. In some countries, schemes are part of overarching European programs such as ERC and Marie Curie and, hence, heavily rely on contributions from EU funds, or schemes are of bilateral and multilateral nature, e.g., with respect to scholarship contribution or organizational design of joint research programs. In others, brain gain schemes are combined with countervailing measures on brain drain in a coherent framework. In terms of outward flows, not all countries facing severe brain drain have prevention policy measures in place, e.g., Cyprus and Belgium, but rather tend to foster international mobility of national students and doctoral students such as in Estonia. Up to one third of post-docs in France continue research programs abroad, in particular in the life sciences and chemistry, and often work at US institutions. Evidence on inter-sectoral researcher mobility is not documented or is not comparable between countries.

- **Providing attractive employment and working conditions**

Cluster evidence on signature of the Charter for Researchers is mixed. While some countries are among early adopters (Austria), progress in adoption in other countries is fairly slow or only happening gradually among a few major/only some institutions (e.g., France and Luxembourg), the Charter is perceived as voluntary and non-legally binding in nature and implementation effort and formal assignment is subject to very autonomous HEIs' decisions (e.g., the UK already having more advanced/detailed standards or in the Netherlands) or collides with other, existing national legislation (Slovenia).

Many countries have shifted towards or already have a tenure track system in place which suggests more attractive working conditions and transparency in terms of promotion, also because some countries (Belgium or the Netherlands) additionally show high success rates in European funds and grant applications as well as state-of-the-art research facilities. In addition, country reports document that HEI and PRO staff is increasingly hired on the basis of temporary employment contracts while permanent positions become less frequent. This is particularly true for early-stage scientists (doctorates and post-docs) as well as staff at non-university research institutions. Short-term contracts are frequently based on third-party funded projects and come along with higher flexibility from university perspective but uncertainty from researcher's perspective. In this way, early-stage researchers are becoming often (necessarily) more mobile in inter-sectoral terms, e.g., starting careers in the private sector and then moving back to the public one. In some countries, universities may choose to contract individual researchers based on private law, including definition of salary levels (e.g., in Austria and Estonia). However, there is still a majority of countries where remuneration schemes are in fact either based on national regulation and aligned with civil servant salaries, at least for senior researchers, or are arranged by collective agreements between universities and staff representatives. Promotion is based on research excellence criteria in some countries, e.g., in Austria increasingly on bibliometric analysis. Social security benefits may be inexistent or limited (excluding pension and unemployment benefits, however including health and maternity ones) for early stage scientists and holders of publicly-funded stipends,

e.g., as in Estonia, while all other science systems within the cluster do not differentiate benefits upon seniority and stipend-holders as compared to other researchers.

With the exception of Slovenia and Estonia, all countries offer research salaries significantly above EU average. Anyhow, in many countries private sector wage levels outperform academic ones (e.g., Estonia). Remuneration and incentive related policies in the context of support to researcher's careers often are difficult to implement coherently due to the fact that competences for various policy aspects are spread across various governance levels and domains, e.g., tax and pension schemes on federal level, while the design of human resources and recruitment strategies issued by fairly autonomous universities. Such policies highlight very different aspects in each country and, hence, documents high levels of policy experimentation:

- 1) increases in grants offered to early stage scientists (Belgium),
- 2) reimbursement of researcher's wage taxes to HEIs, PROs or regional funds in order to foster reinvestment in additional research staff (Belgium),
- 3) progressive wages throughout the career (e.g., Cyprus and the Netherlands), which in some countries compensates for low-entry wages (the UK)
- 4) performance-based bonuses in some countries, e.g., for excellent French scientists or lecturers, and shared earnings from research financed by business sector at PROs in Slovenia
- 5) previous professional experience in the private sector being integrated in entry-level wage assessments and may lead to an increase of up to 15% (again, in France)
- 6) no policies in place that incentivize high quality and productivity of individual researchers at HEIs and PROs (Luxembourg).

Wage differences between male and female researchers are remarkably low in Slovenia while very high in Estonia, i.e. women in research earn about only about half as compared to their male colleagues. All other countries range around European average. In terms of female participation country reports document average rates of 35-50% in early research career stages and frequently more than half of the undergraduate students are female. However, on more senior and advanced career levels this trend is reversed in most countries which implies significant glass ceiling effects (however, largely variant) being in place across all scientific staff and professorships and higher governance levels. Similar holds for participation in the private sector and outside R&D related employment. In this way, e.g., female professors often do not have children and partially this is due to a lack of adequate childcare facilities and that the maternity leave is regarded an unfavourable career break although adequate national legislation is existent. In order to tackle discrimination in senior and more advanced positions at HEIs and PROs a number of countries and/or individual science institutions have responded by a variety of policy measures: 1) quota in university committees and boards of up to 40% or according to overall distribution in academic staff, 2) gender monitoring with respect to applications as well as in governance bodies, 3) targeted recruitment, 4) part-time work option even under temporary employment contracts and possible redefinition of contract objectives, i.e. teaching vs. research obligations in order to balance with family responsibilities, 5) childcare facilities installed at larger hosting, 6) extra funding/grants for

female researchers and lecturers and age limits largely abolished in job postings (the Netherlands). However, some correspondents note that measures are underequipped with budgets. Other measures are part of comprehensive anti-discrimination effort packages involving also inclusion of ethnic minorities (e.g., the UK) and/or handicapped staff. Notably, Belgium and UK policies seem partially effective as female participation in senior and junior positions has increased in the last decade/in the longer-run, while in other countries there is no or little such effect ex post policies (e.g., in France). In other countries, reports do not document any countervailing measures.

- **Open recruitment and portability of grants**

With the exception of Slovenia, the majority of countries and related acting bodies in the national research systems are dedicated to practice open recruitment. This finds support in the wide-ranging evidence on advertising positions internationally, including the European Researcher's Mobility Portal. Many countries are participating in the Euraxess and Bologna related activities and implementation efforts and have established agencies on national levels that are responsible for accreditation of foreign academic certificates or have various bilateral agreements upon mutual accreditation in place. However, to the best of our knowledge only Austria and the Netherlands have assigned to the scientific visa package directive. In general, in most countries, there is no national legislation in place that regulates access to permanent positions and that helps or hinders the openness of science systems to non-nationals, also most research institutions operate on fairly autonomous grounds, which may in a few cases even hinder open recruitment governance (Estonia). However, some informal barriers remains, e.g., such as language requirements related to teaching obligations. In contrast, multilingual culture as in Luxembourg may serve as an asset in terms of open recruitment success, i.e. inward mobility.

As far as documented by country correspondents research grants are not portable (Slovenia and Ireland) or only to a small or moderate extent (Austria, Cyprus, France, Luxembourg and Estonia). In this way, only some countries in the cluster such as Belgium, Estonia, France and the Netherlands have signed the letter of intent related to the money follows researcher initiative issued by EUROHORCS, even though this does not necessarily include all relevant national institutions within a specific country. One notable exception is the Netherlands that allows for international grant transfer at a large extent. For the subgroup that has set certain limits upon portability, these limits are based upon either, a) requirement of individual grant merits rather than organization associated grants (Austria), b) portability assessment on a case-by-case basis in some funding agencies, while in others grants are not footloose as funding connected to regional economic prospects (Belgium), c) portability limited to early-stage scientists (Luxembourg), or is restricted to d) existence of bilateral arrangements with non- and European funding bodies (the UK).

MODERATE INNOVATORS

The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below the EU27 average.

GEO/TIME	R&D intensity (GERD as % of GDP)			Tertiary educational attainment			Employment in KIS sectors ¹⁶ (%)		HRST as a share of labour force			Salaries ¹⁷ (PPS)	Remuneration difference male-female
	2007	2008	2009	2007	2008	2009	2007	2008	2007	2008	2009	2006	2006
EU 27	1,85	1,92	2,01	30,00	31,10	32,30	32,96	:	39,20	39,60	40,10	40126 ¹⁸	:
Czech Republic	1,54	1,47	1,53	13,30	15,40	17,50	25,66	25,63	36,00	37,10	37,90	36950	36,45
Greece	0,58	:	:	26,20	25,60	26,50	25,07	25,73	31,20	31,70	31,80	30835	14,27
Hungary	0,97	1	1,15	20,10	22,40	23,90	28,20	28,73	31,70	33,20	33,20	27692	25,04
Italy	1,18	1,23	1,27	18,60	19,20	19,00	30,67	31,02	35,60	35,30	34,30	34120	33,27
Malta	0,58	0,57	0,54	21,50	21,00	21,10	32,82	32,67	31,90	32,10	32,30	40342	-5,94
Poland	0,57	0,6	0,68	27,00	29,70	32,80	24,81	:	32,50	33,40	34,90	21591	28,85
Portugal	1,17	1,5	1,66	19,80	21,60	21,10	23,51	23,79	22,10	23,10	23,50	33334	36,76
Slovakia	0,46	0,47	0,48	14,80	15,80	17,60	24,74	24,71	31,80	32,00	32,00	18282	21,56
Spain	1,27	1,35	1,38	39,50	39,80	39,40	28,19	28,89	39,70	39,70	39,00	38873	25,79

Source: EUROSTAT

• Stocks and mobility flows of researchers

All countries have an R&D intensity significantly below European average. In this way, demand for human resources in STI is likely to be relatively lower, especially in Greece, Malta, Poland and Slovakia and further decreased by the current crisis. On the supply side, the share of citizens with tertiary educational attainment as well as employment in knowledge intensive sectors is around or below the average European level. Similar holds for the share of HRST in the total labour force. This partially does not necessarily imply a mismatch, however, relatively smaller research labour markets than elsewhere in the EU, controlling for the overall size of the economy. Notably, information from country reports and above table highlight increases on the supply side of such markets in a few countries while demand stagnated in the recent years, in particular, e.g., in the Czech Republic the overall number of PhD has increased since 2000 in line with average increases across Europe. Evidence in the country reports on mobility patterns, in particular with respect to destination/ source of flows is scarce. However, correspondents argue mostly for negative national balances, i.e. higher

¹⁶ Share of total employment

¹⁷ Researchers salaries

¹⁸ EU25

rates of brain drain as compared to brain gain. With regard to inward mobility HRST shares of foreign nationality mostly account for only 2-6%¹⁹. Notable exceptions are Hungary, Portugal and Czech Republic. However, high Czech shares are partially explained by high rates of foreigners of Slovak nationality (2/3) and, hence, common national history. Similar applies to high shares of foreign-born HRST in Slovakia, of about 18%. In addition, the share of foreign-born researcher active in Portugal as an indicator of inward mobility is significantly higher than by the foreign nationality definition (11% and 5%, respectively). In general, the majority of foreign researchers in most countries is from other European MS, likely from neighbouring ones. While there is very little evidence on foreign-held senior positions, early academic stages seem more frequently occupied by non-nationals. Barriers to inward mobility include national accreditation requirements of foreign degrees in order to be eligible for post-doc and permanent academic positions, language barriers, informal protection of internal candidates, and instability of working contracts as well as poor promotion prospects.

Limited scope of (e.g., university budgets and scarce funding in general) and high, supply-side competition on research labour markets lead early stage researchers to either not follow academic career tracks and target non-research employment or continue research abroad, i.e. which raises national concerns on excessive brain drain. However, even when changing to private sectors highly-trained candidates face relatively poorer job prospects in national domains, e.g., in Italy or Portugal. Frequently, PhDs are already obtained from universities abroad rather than national ones, often due to inexistent national programs on this level. For example, Greece ranks second with respect to PhD studies pursued in another European MS. In addition, senior scholars are less likely to engage in research abroad as frequently unable to cope with foreign language requirements, unwilling to lose personal contacts in home institutions and respective hierarchies as well as this being no need in career development and promotion terms.

Around 2/3 of the countries have implemented schemes to support inward mobility, many of them highlighting the importance to re-attract nationals working abroad. Only Spain, Malta and Slovakia have no such incentive programs in place. Support schemes on inward and outward mobility are likely to focus on early stage researchers. Poland is about to change regulation on academic career tracks in favour of reintegration of nationals and non-nationals carrying out excellent research abroad to high-level positions at national HEIs. In addition, Portuguese schemes have a slightly different focus on attracting early-stage scientists from third countries, e.g., in this way facilitating visa requirements²⁰ as well as subsidizing foreign-held professorships since 2008 under the invited chair scheme. If outward mobility has increased in some countries, this was likely due to participation in EU schemes such as Erasmus (on student level), Marie Curie (on postgraduate levels) and Leonardo da Vinci (on university teacher level) programs, especially in late accession countries such as Czech

¹⁹ Note that EUROSTAT information on this indicator is not available for Malta and Slovakia in 2009.

²⁰ Unfortunately, some of the intended changes with respect to visa requirements have been revoked in the present crisis context.

Republic or Poland. National policy efforts on mobility in a few countries have been complemented by regional level efforts, e.g., in Spain or Italy.

- **Providing attractive employment and working conditions**

The European Charter of Researchers has been signed by all major institutions of the specific science system, in particular public institutions of science, in only half of the countries, including e.g., the Czech Republic, Malta, Slovak Republic and Italy. However, in all other cases, national science institutions have been more or less reluctant to join and de facto implement the Charter such as in Greece (only around 10-15% of HEIs and PROs), Hungary, Spain (even though public funding legally requires implementation) and Portugal (nationwide only four institutions have signed it).

With the exceptions of Malta and Spain ranging around EU average in terms of researcher remuneration, scientists in all other countries in the cluster are offered salaries significantly below this average and are mostly determined by national laws regulating public servant salaries or collective agreements at HEIs and/or PROs. However, with increasing ex ante work experience and seniority levels on the job relative salary situation of countries improves (e.g., Italy) or loses further ground (e.g., Hungary), even though increasing in absolute terms in most countries. The monetary attractiveness of research careers is particularly low in Poland, Slovakia and Hungary, with only about half of the EU average, and notwithstanding high societal acknowledgement of working in science or comparative to private sector payment. However, the budgetary situation in 1/3 of all countries (and related salary cuts) in the crisis context may further threaten international competitiveness and competitiveness with regard to private sector payment, especially in Greece, Slovak Republic and Portugal. Anyhow, the likelihood of unemployment, with the exception of the above noted Italy and Portugal, frequently decreases with higher education levels achieved, i.e. tertiary education attainment and even more advanced degrees, as compared to the rest of the workforce. Supplementary salaries and bonuses can be achieved by participation in third-party funded projects, external consultancy or even (non-research) activities. Bonuses based on high scientific performance are less frequently included or only limited in scope in payment schemes. In a very few countries, bonuses do not really differentiate according to scientific performance but mechanisms have been "hijacked" in order to generally increase all salaries, namely in Spain.

Most countries do not have an explicit tenure track system in place or implementation is poor. Furthermore, PhD programs are limited in terms of curricula alignment with industry needs as well as little equipped with public budgets which contribute along other factors to brain drain, especially at early-stage science careers. With regard to social security benefits for publicly-funded stipends for researchers (including doctoral candidates) only the Czech Republic does not provide sickness, maternity or unemployment benefits but pension ones. The same is true for maternity leave benefits in Poland, unemployment benefits in Malta, and unemployment and pension benefits in Portugal. All other countries offer the full package of social security benefits for such research positions. However, in some places in order to qualify for such

benefits a certain working period *ex ante* is required which, in particular for early-stage scientists based on short-term fixed employment, is not necessarily met. In other places, relatively large wage shares are supplements and are excluded once the pension and social security payments are calculated which significantly lowers benefit scope.

In order to tackle the low attractiveness of the labour markets in some of these countries, national policies have been issued accordingly, including among others: 1) support to inter-sectoral mobility in the Czech Republic, 2) additional national grants issued for those early-stage researchers in Italy that are selected but do not actually win ERC grants. Some of these policy efforts are largely based on investments from EU structural funds.

Notably, half of the cluster countries have male-female wage differences well below EU average. This includes countries such as Greece, Slovakia and Malta, whereby some of these have traditionally equivalent shares of employment in the overall labour market. Female participation in science is around or higher than EU averages. The proportion of PhD students is about half, for higher positions²¹ it is still about 20 up to 45%, which is, again, somewhat above EU levels. In addition, gender representation on governance levels of scientific institutions is assured in some countries, e.g., Italy. However, the lack of childcare facilities and specific policy efforts are arguably raised as factors that limit female participation in scientific labour market. Fixed contracts are not necessarily prolonged in the case of maternity leave, while the return to the same position is safeguard for permanent position. In many countries, no specific measures, to date, have been implemented with respect to unequal female recruitment in research careers. Anyhow, a few countries have targeted related aspects by, exemplarily, increasing flexibility for shared parental leave, tele-working opportunities and accreditation of social security contributions of the parents on the first two years of parental leave (Malta).

- **Open recruitment and portability of grants**

Some of the evidence in country reports suggests that openness may suffer from often slow administrative accreditation of foreign candidates' academic certificates, scarce possibility of related online-services as well as non-transparent selection procedures in general. In a few countries, however, accreditation processes are currently under review with the purpose of simplification for excellent foreign researchers, namely, in Poland. Language prerequisites for advertised positions and selection procedures may further hinder open recruitment of non-nationals in most countries of the cluster. Permanent positions are often only advertised on the institutions website or on national media, while advertising on international levels, i.e. on the national Euraxess portals, if existent, is less frequent and more likely at professorship levels. In addition, many country correspondents document the non-competitive, endogamy nature of selection outcomes, e.g., in more than 70% of Spain's examinations for permanent positions there was only one candidate and in more than 90% the internal candidate has been selected,

²¹ For the top end of high level positions, i.e. rectors and research directors at HEI and PROs, respectively, this rate is likely lower, about 10-15%.

as compared to 10-15% in the US and UK. Similar holds for recruitment results in Greece. In most countries, more generally, national laws do not hinder nor do they encourage participation of non-nationals. One exception is the unfavourable treatment in terms of work and residence permits of third country researcher as compared to the EU MS citizens e.g., in the Slovak Republic. However, the Scientific Visa Package related EC directive has been implemented in Italian and Maltese law which constitute rather exceptional cases in the cluster. In this way, it is frequently left to research institutions themselves to set up measures that foster openness when implementing standard hiring processes and HR strategies.

Grant portability is not permitted in most of the countries of the clusters. Even portability of individual grants from one institutions to another within a country may be strictly forbidden (in particular for non-nationals) or may require significant administrative efforts, e.g., permission by research institutions with respect to transferability of related social security and supplementary pension benefits. However, in a few countries such as Italy, transferability of social security benefits (not exclusively for researchers but for the overall workforce) is assured also with third countries via bi- and multilateral agreements on national level.

MODEST INNOVATORS

The performance of Bulgaria, Latvia, Lithuania and Romania is well below the EU27 average.
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All these countries have an R&D intensity significantly below EU average. Chronic shortage of public R&D resources, stretched across an oversized public institutional structure inherited from central planning, has triggered long term effects on the science base. Due to chronic underinvestment and the low attractiveness of the research career, for example Romania faced a drastic (~51%) quantitative and qualitative loss of the human resources between 1990 and 2002. Although these countries show high increase of various innovation indicators, this largely the catching-up effect, overall, still lagging well below the EU average. The prevailing public funding of research activities is also an indicative of problems related to the efficiency of research in stimulating economic growth. There is low tradition of public-private R&D collaboration and low innovation culture. The national industry structure reflects the prevalence of traditional industrial sectors, which use relatively low technologies and show a weak demand for knowledge. Business R&D is largely dependent on public funding, mainly Structural Funds dispersed through Operational Programmes. Consequently, the human resources in science and technology as a share of labour force rank these countries among the EU laggards. In addition the largest share of the R&D personnel is in the public R&D sector. Despite increased possibilities at PhD level, provided mainly under the Operational Programme “Human Resources Development”, the long term attractiveness of the research careers remains low. The crisis led to budget cuts for R&D and education and reduction of vacancies of R&D positions. There are also additional negative effects induced by ageing of the R&D personnel and brain drain.

The low salaries, slow career progression in the S&T/RDI system generate brain drain and /or migration to other more attractive national sectors. The inflow of foreign researchers is very limited and mainly to short term mobility within R&D collaboration schemes. Specific schemes were designed to re-attract nationals working abroad, yet their impact is low. Support schemes for outward mobility focus on early stage researchers.

Although difficult to assess, the magnitude of the brain drain and more specifically of the emigration of scientists and engineers (S&E) is high, particularly in Romania. According to the EC survey, Romania has one of the highest intra-EU net losses in absolute terms, accounting to 8.9% of their number of doctoral candidates (Moguerou and Di Pietrogiacomo, 2008). It also accounts as one of the European countries with the highest number of students in USA, showing a positive increase over time. Empirical proofs further show that many talented scientists and engineers have been misused or underutilised when they returned, either because of inappropriate research facilities for the research field in which they performed abroad or rigid promotion systems. The main push/pull factors determining the migration of Romanian researchers are: job and career opportunities, a search for a positive working, political and social environment, mistrust in the political class and the low life quality, summarised as "*better brain drain than brain waste*".

- **Providing attractive employment and working conditions**

The national R&D institutions have been mainly reluctant to join the Charter, while, the impact for those which signed seems rather marginal. Academics and researchers in all the cluster countries have salaries significantly below the EU average and are mostly determined by national laws, which define an interval with the lowest and highest possible salary for a specific academic, researcher rank. Salary flexibility, awarding the scientific performance is limited or inexistent, salary being generally based on the rank and seniority. Supplementary financial benefits may be achieved by participation in third party funded projects. The attractiveness of research careers is particularly low, the crisis triggering further salary cuts, slower promotion and decreased public funds for R&D projects. Unattractive employment and working conditions (low salaries and poor access to academic databases and libraries, world class research infrastructures, limited finances for research activities) are the main obstacles for making the research careers attractive.

The gap in the annual average salary between men and women increases with experience, the number of women in much better paid leadership and/ or academic positions in institutions of higher education is still very small. There is no evidence of any systemic policy actions or regulation promoting equal gender representation in academic and research committees, boards and governing bodies.

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- **Open recruitment and portability of grants**

Some of the evidence in country reports suggests that openness may suffer from slow administrative accreditation, scarce possibility of related online-services as well as non-transparent selection procedures in general. While the relevant legislation has been mainly revised to allow access to the EU citizens, the labour market for researchers remain largely unattractive and lacks competitiveness. The Scientific Visa EC directive has been implemented, yet overall the inflow remains limited. Grant portability is mainly restricted, even in the case of individual grants from one institution to another within a country or may require significant administrative efforts.

- **Meeting the social security and supplementary pension needs of mobile researchers**

The tax regime, health and social security provisions applicable to EU researchers employed in these countries are regulated by legislative frameworks, generally recently revised in order to be harmonised with the relevant EU legislation and regulations. Nevertheless, the complex bureaucratic systems may occasionally hamper its implementation.

- **Enhancing the training, skills and experience of European researchers**

The higher education system was restructured according to the objectives of the Bologna Declaration. Doctoral and postdoctoral programmes are supported through the Human Resources Programme, as well as some bilateral collaboration agreements that give young researchers and doctoral students the opportunity to participate in short term fellowships. As regards the mobility of permanent research staff, short-term visits dominate.

MODERNISING RESEARCH ORGANIZATIONS, IN PARTICULAR UNIVERSITIES, WITH THE AIM TO PROMOTE SCIENTIFIC EXCELLENCE AND EFFECTIVE KNOWLEDGE SHARING

INNOVATION LEADERS

Denmark, Finland, Germany, Sweden all perform well above the EU27 average.
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- **Quality of National Higher Education System**

The HE landscape in the innovation leader countries shows variety and different level of reform. Germany has a highly diversified HE system, encompassing 409 Higher Education Institutions and two main models: universities, offering theoretical and science education at undergraduate and postgraduate level and universities of applied sciences which focus on applied education. In addition to these, there are special universities focusing on arts or music and recently developed, “duale Ausbildung” which combines applied studies with vocational

training. There is also an increasing number of privately operated universities (around 132; BMBF, 2010).

While the size and complexity of German system is justified by the federal governing and size of the country, Finland, comprising 16 universities and 25 polytechnics has an exceptionally large HE system compared to its size. The Swedish HE sector consists of two main models: universities (14) and university colleges (22). The main difference between university colleges and universities is that the latter can organise in addition two-year Master degree and doctoral degrees and are entitled to government funding for research.

The HE system in Denmark was reformed in 2007, in response to the 2002 OECD evaluation. The reform included the reorganisation of the academic and research landscape: 12 universities and 13 PROs were restructured in eight universities and three national PROs.

In terms of excellence, Germany and Sweden score high in many OECD evaluations and university ranking (according to the 2012 Shanghai top 100 HE index, Germany has four universities, Sweden three, Denmark two and Finland one university).

The mission statements of HEIs in all these countries generally include quality of academic research and education, transfer of knowledge and strengthening international cooperation. The third mission is important, various relevant indicators such as the number of patents, spin-offs and annual revenues from sales of licences being used in the evaluations of the universities. Also, many universities have their own KTO.

- **University autonomy**

Scandinavian universities have traditionally enjoyed a great degree of autonomy, which was further strengthened by the undergoing university reform and enforced by the new legislation (University Act, Demark, 2009, Finland, 2010 and 2009 Govt. Bill 2009/10:149 in Sweden). The reform includes the structural reorganisation of the HE landscape (DK and FI) and increased level of autonomy regarding management of research budgets and hiring of research personnel. Decisions about researchers' salaries are generally delegated to the universities, however within the framework determined by an agreement between the government and union. The new national legislations also require university boards to have external members. This however has been debated by the academic community as potentially having adverse affect on university autonomy. The increased share of competitive funding for thematic research it is also seen as contributing to pressure on universities to align their research agenda to nationally agreed S&T priorities. While the university landscape has the common features mentioned above, distinct rules, reform path may exist.

For example, in Denmark, the academic autonomy is framed by three years government contracts between the Ministry of Science, Technology and Innovation and the individual universities. The reform also changed the role of the university collegiate from decision-making to a more advisory one and the governing bodies to university boards comprising representatives of the staff, students and external members. The 2009 Swedish 2009 bill (Govt. Bill 2009/10:149) gives also provisions for a less regulated HE framework: faculty

boards discontinue to be regulated by the Higher Education Ordinance, while although the positions of Professor and Senior Lecturer continue to be regulated by this Ordinance, HEIs can determine their own career structures and recruitment process. Rectors, deans and HEI managers can either be recruited through an open tender process (lately increasing) or elected among peers (previously dominant pattern).

In contrast to the Scandinavian university landscape, traditionally enjoying high autonomy, German HEIs have rather limited autonomy (European University Association, 2009). The German federal states have strong competences in defining the framework and legislation for HE, therefore the relevant laws and the resulting autonomy vary between the 16 states. In some states, the government predetermines the number of faculties, professorship and students, while the appointment of professors has to be confirmed by the relevant state ministry. Salaries are partially determined by the states, allowing marginal variation, although the salary ceiling was abolished. University land and buildings, in most cases are owned by the state. The implementation of tuition fees is decided on the state level, with the exception of Bavaria, where the amount is determined at university-level.

In recent years a new governing model, the university council (Hochschulrat) has been introduced in several states such as North Rhine-Westphalia (in 2007) and Saxony (in 2009) and involves external stakeholders in the council. Primarily, university councils have advisory functions regarding the strategic direction of the university. In some states they also elect the university's rector.

The German Science Council, the advisory body to the federal government and the state governments, makes recommendations on the organisation of HEIs, e.g., regarding the academic personnel, courses and on the systematic development of this sector. The WR is also responsible for the institutional accreditation of private universities.

- **Academic funding**

In all countries of the group, the universities receive both institutional and competitive funding. In the Scandinavian countries, the block funds are distributed among universities based on criteria that consider also performance indicators. There is a trend of increased share of competitive vs. block funding and of new distribution models of block funds with stronger focus on the performance criteria. In Denmark for example a new such distribution model for core funding was agreed in 2009 and should be implemented stepwise over the period 2010–2012. The envisioned distribution is 45% based on education appropriations, 20% based on external funding of R&D activities, 25% based on bibliometric indicators and 10% based on number of PhD graduates. In Finland, public funding covers 64% of the total HEI budget, with a significant share allocated for research. Starting 2010, the block funding follows the same principles for all universities: 75% is allocated on the basis of the core elements and 25% on the university policy and strategy considerations. In Finland, industry and funds for collaborative research (mainly through Tekes) finance to a considerable extent the research performed in HEIs, tendency reflected also in the growing number of externally funded professorships. Contrary to the budget cuts observed in other EU countries, in 2009, Sweden

increased the budget allocated to HEIs through the multi-annual planning, the additional budget and 10% of the planned budget being exclusively distributed on performance criteria. In addition, in June 2010, the Parliament decided that starting 2012 (Focus on knowledge – quality in higher education, Government Bill 2009/10:139), performance based funding should be introduced for HE.

In Germany, block funding for public research institutes is provided by the federal and central government and only in some states distributed against performance criteria that include research performance indicators. Since 2006, additional funding (nearly €2b) is allocated for academic research according to excellence criteria (“Initiative for Excellence”), while about €1b competitive funds are allocated for research through the German Research Foundation. The freedom regarding the allocation of governmental funds is also rather limited, the Academic Freedom Act (Wissenschaftsfreiheitsgesetz) providing some flexibility in the 2009 budget.

In all these countries specific bodies are responsible for institutional accreditation, making recommendations on the systematic development of the HEI sector, while appropriate evaluation mechanisms are in place.

INNOVATION FOLLOWERS

Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK all perform close to the EU27 average.

In general, most universities and other HEIs have a strong, balanced focus on the dual mission including teaching as well as high-quality research obligations. In the recent years, this has been expanded to a third mission (of relatively minor scope and importance). In some cases, country experts argue that teaching obligations often further cannibalize research efforts, making the former even slightly more important than the latter. However, national and institutional level third mission aspects and interpretations themselves largely vary and are fixed on national and/or institutional levels (as far as evidenced in country reports), i.e., in some countries, this comprehends HEI contribution to regional economic and/or social development/communities or engagement in inter-university and industry cooperation. In other countries, additional HEI contributions are expected to emerge on international levels such as ERA e.g., by university promotion of international researcher mobility. In a few countries, country reports document (to a certain degree) specialization along missions among HEI and PRO institutions. In relatively smaller science systems (in terms of research institutions involved), only a share of universities focuses on high-quality research while all others, e.g., universities of applied sciences are mostly dedicated to the education and teaching mission. In addition, regulations on student permission to different types of national HEIs as well as distribution and competitiveness of public funding largely shape ex ante the extent to which HEIs may be able to keep up with the various missions.

With respect to performance, domestic higher education expenditures in R&D (as a percentage of gross domestic expenditure in R&D) range between 9 up to 42% in 2009. On an average, among "innovation follower" countries, expenditures of HEIs account for 27% of GERD. Again, in some countries only a small fraction of HEI institutions perform competitively on international research levels in accordance with the general mission specialization of institutions described above, in particular, as is the case among smaller countries/systems of science. In this way, participation in, e.g., FP7, was largely driven by this fraction, however, fairly effective, as far as evidenced in some of the country reports. E.g., in Austria, HEIs were the most successful FP7 applicants followed by PROs and industry actors, similar holds for HEI in the Netherlands. International scientific co-publication and related impact is relatively high in some countries, e.g., in Belgium reaches up to 54% of all HEI launched publications while in the Netherlands shares range between 38 up to 52% depending on the various scientific disciplines. Other countries report increasing numbers of scientific publications (e.g., Cyprus), however, do not elaborate on quality of the latter.

All of the countries have fairly independently working, quality assurance mechanisms in place with respect to domestic academic institutions, HEIs and, most frequently, PROs. However, in a very few cases agencies responsible for implementation/evaluation have only been introduced recently, e.g., in Slovenia. In many other countries, there is a long-standing, cyclical record of evaluation practice and continuous improvement of mechanisms with regard to systemic reviews and external/international auditing has been achieved, e.g., the UK, Austria and the Netherlands. In addition, e.g., the Austrian Agency for Quality Assurance can be seen as a best practice case for Europe as it does not solely assess and evaluate HEI performance but also advises institutions on further strategic development and general advancement (currently, some German HEIs undergoing the agency's inspection). Typically, external evaluation of HEI sequence less frequently (however, still, on a regular basis) than internal/self-assessments assessments, often requiring international expertise in evaluation committees. E.g., in the Netherlands the former is due every three years while the latter is only due every six years. Assessments in many countries require national or international comparison with other, similar research centres or universities and may cover not only research programmes and teaching but also, in more advanced countries, assessment of overall HEI strategy, management and mission performance. However, the degree of analytical requirements of such assessments differs to a certain extent across countries, e.g., ranging from ambitious indicators and performance measurement allowing for inter-temporal comparison to more qualitative assessments/annual reports. In very few countries, assessment agencies also have the right to give institutional accreditation as HEI.

Recent changes in HEI regulation further increase academic and financial autonomy in most countries. However, in a few countries, in the context of the crisis", governments have taken measures that may limit HEI activities and productivity in the medium and long-run, e.g., an increased student fee cap in the UK that disadvantages entry of less well-off youngsters as well as academic employment restrictions in Irish HEI. In contrast, changes which favour

financial and academic autonomy of domestic HEIs include regulatory efforts on academic employment autonomy and on performance contracts with increased HEI budget autonomy, mostly, by means of enhanced block funding.

MODERATE INNOVATORS

The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below the EU27 average.

HEIs' missions focus more on teaching than research ones. An important institutional characteristic of many science systems is the co-existence of public and private HEIs as well as universities and polytechnics in national landscapes. Polytechnics and private HEIs typically focus on teaching and to a lower extent on research. Similarly, often national HEI research efforts are concentrated among a few larger, elite universities. This often implicitly establishes and may reinforce an elite type of science system, in particular, with respect to student access to private HEIs, but also regarding R&D carried out. If any third mission obligation and related regulatory effort on national or institutional levels is in place and very seldom public budget/funding has been specified in this respect, they have had (so far) only very limited acceptance within the academic community. However, in a very few countries, HEI governing bodies now include representatives from civil society and industry as well as their research profiles are getting aligned with industrial research clusters, both, with potential long-term effects on knowledge and technology transfer.

With respect to performance, domestic higher education expenditures in R&D (as a percentage of gross domestic expenditure in R&D) range between 18 up to 35% in 2009 and are, hence, less variant than among "innovation followers". On an average, among "moderately innovating" countries, expenditure of HEIs accounts for 28% of GERD. Quality as measured by international co-publications is relatively lower than among "innovation followers", HEIs often not being very outward looking in principle and less likely to publish results in another language. Nevertheless, HEIs and academies of science account for half up to a majority of domestic scientific output (in absolute terms) in most countries. Applicability and transferability of HEIs research results seems limited as only a smaller fraction (between 0-25%) results in patent applications and, more generally, business funding for HEI is eventually underdeveloped ex ante. However, in a few positive cases, e.g., in Portugal, the number of researchers as well as PhD holders is increasing, corresponding to an increase in scientific publications, in particular international co-publications (49% in 2009, while being at

39% in 1990), on ISI levels. As far as documented by country experts, none of the domestic HEIs ranks among the Top 100 in global rankings.

Only about half of the countries have quality assurance mechanisms in place with regard to domestic academic institutions. Anyhow, in many countries where no such mechanisms exist there is either only regulatory reform underway or existing HEI laws are largely ineffective, i.e. often suffer from implementation and, hence, remain largely on paper. More promising, recent regulatory HEI reforms highlight the introduction of quality assurance mechanisms and more competitive and transparent academic career path, e.g., as in Poland. In some countries, regulatory changes address specific areas of HEI governance or are limited to individual researchers and not research institutions, e.g. the former with respect to doctoral training accreditation and related quality assurance, the latter with regard to national accreditation systems that control access to specific academic positions. Ineffective reforms elsewhere suggest quality mechanism failure due to missing international/external or systematic institutional reviews and assessments being treated as a formal requirement rather than a learning exercise for HEI improvement and competitive comparison, e.g., leaving the definition of performance criteria, sequencing and requirements of internal self-assessments to individual HEIs.

MODEST INNOVATORS

The performance of Bulgaria, Latvia, Lithuania and Romania is well below the EU27 average

The number of universities has expanded rapidly in the last two decades, with an increasing share of the newly established private universities. HEIs, especially private ones, have often responded to the immediate demand of the target population, without taking into consideration the medium and long-term economic needs. As a consequence, HE sectors have faced a significant increase of the number of students in some fields, that triggered the rapid and artificial rise of the number of specific faculties, often showing very low scientific performance.

Although the funds allocated to higher education have increased, this increase did not necessarily match the increase of the number of students, the share of funding per student being among the lowest in the EU. HERD is low compared to the EU-27 average, further decreasing during the economic recession, in the same way as GERD.

Following the Bologna process recommendations, systems and mechanisms for quality control of HEIs have been established, yet their functioning is generally perceived as ineffective. Special attention is increasingly being paid to the assessment of research activities and the research output in the block funding allocation. Nevertheless, Bologna requirements seemingly did not trigger necessarily positive effects. Quality suffering as the educational system expands and restructures to comply with Bologna system is a syndrome of the current Romanian HE system.

The primary mission of the HEIs is teaching, and only recently research started to be included in the HEIs' mission. The *third mission of universities - contribution to the local or regional wealth and economic development* - is in a very incipient stage, with only a few universities consolidating their technology transfer and commercialization infrastructure and personnel.

The national HE systems show low international competitiveness in attracting young 'brains', having the lowest percentages of foreign PhD students from foreign countries. Moreover, they have a very high share of students choosing to do their PhD studies abroad (Romania has the top position in terms of brain lost and one of the highest in EU). The international research performance of the national universities is modest, as none of these countries has any university in the Shanghai Academic Ranking of Top 500 World Universities. This suggests poor research productivity.

Among the major problems faced by the HE systems in these countries are: the distribution of the limited public budget resources across a large number of institutions; the deteriorating status and conditions of academic staff and their working conditions; the lack of management experience; inefficient evaluation. Occasionally, as is the case in Romania, criteria for academic promotion have been recently revised and institutional and individual evaluations are implemented against criteria that may not suit the national context and reality, with a chronic under-investment for research and education.

- **Academic autonomy**

4 The legal frameworks regulating the higher education system have been recently revised, HEIs being autonomous institutions with the right to self-governance. HEIs are essentially free to develop their own academic profiles, the design of curricula being generally decided by HEIs themselves, but the introduction of new programmes is subject to accreditation procedures. The revised laws ensure in principle the three types of academic autonomy, yet provide also the constraints for it. Very much debated is the new Romanian Education Law (2011) with regards the procedure for the election the Rector. The salaries of the university personnel are decided within a range established by the national legislation.

- **Academic funding**

5 The funding of public universities is implemented through subsidies from the state budget and own revenues from research, consultancy, and revenues from tuition fees. In the last years, the share of the competitive funding has generally increased, while the indicators of the research performance are gradually integrated in the allocation of the block funds.

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OPENING UP AND CO-ORDINATION OF NATIONAL RESEARCH PROGRAMMES AND OPENING UP

INNOVATION LEADERS

Denmark, Finland, Germany, Sweden all perform well above the EU27 average.

- **National participation in intergovernmental organisations and schemes**

All these countries actively participate in collaborative intergovernmental research infrastructures, in EU FP7, EUREKA and COST programmes. Various national schemes are in place at national level to support the national participation in these programmes.

Table 1. Participation in FP7

	Sweden ²²	Finland ²³	Denmark ²⁴	Germany ²⁵
Innovation Union Scoreboard position	1	4	2	3
R&D intensity target	4%	4%	3%	3%
2010 R&D intensity	3.4%	3.8%	3%	2.82%
Total number of participants, total EU financial contribution €million	2.782 participants receiving € 1.017,98 in FP7	1.687 participants receiving € 557,90 in FP7	1.631 participants receiving € 594,05 in FP7	11.141 participants receiving € 4.323,16 in FP7
Success rate	24,1%	22,7%	24,3%	24,0%
Rank in number of participants signed contracts (EU-27)	8	11	12	1
Rank in budget share (EU-27) 8	8	12	11	1
Top collaborative links	1. DE - Germany (5.486) 2. UK - United Kingdom (4.165) 3. FR - France (3.545) 4. IT - Italy (2.943) 5. ES - Spain (2.305)	1. DE - Germany (3.294) 2. UK - United Kingdom (2.259) 3. FR - France (1.934) 4. IT - Italy (1.697) 5. ES - Spain (1.632)	1. DE - Germany (2.671) 2. UK - United Kingdom (2.451) 3. FR - France (1.614) 4. IT - Italy (1.498) 5. ES - Spain (1.354)	1. UK - United Kingdom (15.479) 2. FR - France (14.849) 3. IT - Italy (12.712) 4. ES - Spain (9.466) 5. NL - Netherlands (8.345)
Total Population & EU 27 Population Share	9.415.570 (1.9% of EU-27)	5.375.276 (1.1 % of EU-27)	5.560.628 (1.1% of EU-27)	81.751.602 (16.3% of EU-27)

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http://ec.europa.eu/research/fp7/pdf/country-profiles/sweden/country_profile_and_featured_projects.pdf#view=fit&pagemode=none

23

http://ec.europa.eu/research/fp7/pdf/country-profiles/finland/country_profile_and_featured_projects.pdf#view=fit&pagemode=none

24

http://ec.europa.eu/research/fp7/pdf/country-profiles/denmark/country_profile_and_featured_projects.pdf#view=fit&pagemode=none

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http://ec.europa.eu/research/fp7/pdf/country-profiles/germany/country_profile_and_featured_projects.pdf#view=fit&pagemode=none

With 11141 participants, coordinating around of 18% of the total of FP7 projects and receiving €4.323,16 that amounts 20% of the FP7 funds, Germany has the top position in the participation in FP7 (EC, (BMBF, 2010a). In terms of budget share Sweden is positioned on the 8th place, Denmark on the 11th, while Denmark on the 12th. Taking in consideration the low shares in the EU27 population, the participation of the Scandinavian countries in FP7 can be assessed as very high. All the countries have a success rate of 22-24.5%.

Denmark is best represented in Article 169 Initiatives and Joint Technology Initiatives, while participation in ERA-NETS is rather low according to the DAST report (DASTI, 2010a). Danish participation is particularly strong in the areas of medicine and agriculture, while Finland in ICT. German participants were involved in 232 EUREKA projects with a budget of €510m (BMBF, 2010a), and in 98% of all COST actions (215 out of a 220 total). The area of ICT, industrial process engineering, biotechnology, medical devices are among the top research field in these collaborations.

- **Bi- and multilateral agreements with other ERA countries**

The joint cooperation framework between the Nordic countries represents a particularity regarding the R&D agreements. Based on geographic proximity, cultural affinity, the framework has specific instruments and strategy, being coordinated by NordForsk, established in 2005 and operating under the Nordic Council of Ministers for Education and Research. A common strategy was designed with the aim of improving the co-operation between the national research funding bodies and developing the Nordic Research and Innovation Area (NORIA) as a region in which knowledge moves freely across national borders and excellent research and innovation institutions. The cooperation has been facilitated by various instruments such as the Epidemiology Research Programme (2003–2007); Nordunet3; Nordic Energy Research; NORDSIM, NDGF, the NordBib Programme (2006–2009). The *Nordic Centres of Excellence (NCoE)* finances top level research centres, integrating the dimension of international collaboration. The Nordic research cooperation is expanding to the Baltic States, arctic research and cooperation with Russia. The research collaboration between Denmark and Sweden in the cross-border Öresund Science Region is another example of successful Nordic collaboration, where four innovative platforms bring together regional authorities, businesses and eleven universities from both sides of the border, to specialise in ICT, food, environment and logistics.

With a long tradition in scientific collaboration, Germany explicitly integrated in the government strategy the need of internationalisation of the scientific collaboration in 2008 (BMBF, 2008a). Numerous bilateral agreements, established at different levels with EU countries or institutions, have common research targets or aim to bring research institutes under a common roof. The main initiatives are “customised” to the benefit of the integrated countries. For instance, together with five countries from central and Eastern Europe (Poland, the Czech Republic, Hungary, Romania, and Bulgaria), Germany entered into a dialogue on

sustainability research in 2007 while close relationships are maintained with other Western European countries France, Austria, the Netherlands, and Norway.

- **Opening up of national R&D programmes**

In Sweden, although the international cooperation is a central part of the activities, funding is rarely available for foreign based researchers. The recent research bill highlights the need to strengthen the international dimension of research policy, defining clear objectives for international collaboration. With a trend towards encouraging international collaborations, funding schemes that are open up to international actors may become an option. However, it is not clear to what extent public research funding can be used outside the Swedish borders

In Denmark, generally, the national schemes do not have specific requirements regarding the applicant's citizenship, geographical location of the research activities, the applications being assessed on the basis of the potential benefits to national research. Some research programmes specifically include the possibility to fund foreign research groups, however bounded by specific constraints. Foreign research groups can also apply for funding within the Strategic Network Project scheme.

In 2009, six out of the ten Research Programmes of the Academy of Finland were open to foreign participation and all the programmes recently launched and not having a specific national target, will include an international dimension.

In Germany the policy framework provides certain tools to move towards opening up, such as the general option to subcontract foreign partners if no national expertise is available and the general openness to European partners if nothing else is stated, but implementation is programme specific. The modalities range from mere acceptance of foreign partners in research projects, without any explicit rule for funding, to the compulsory participation of foreign research performers and funds allocation to the latter. The 2008 internationalisation strategy goes beyond targeting 20% participation of foreign partners in BMBF-funded projects (BMBF, 2008). Until recently, strategies for the opening up of research programmes were often driven by funding agencies such as the German Research Foundation.

INNOVATION FOLLOWERS

Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK all perform close to the EU27 average.

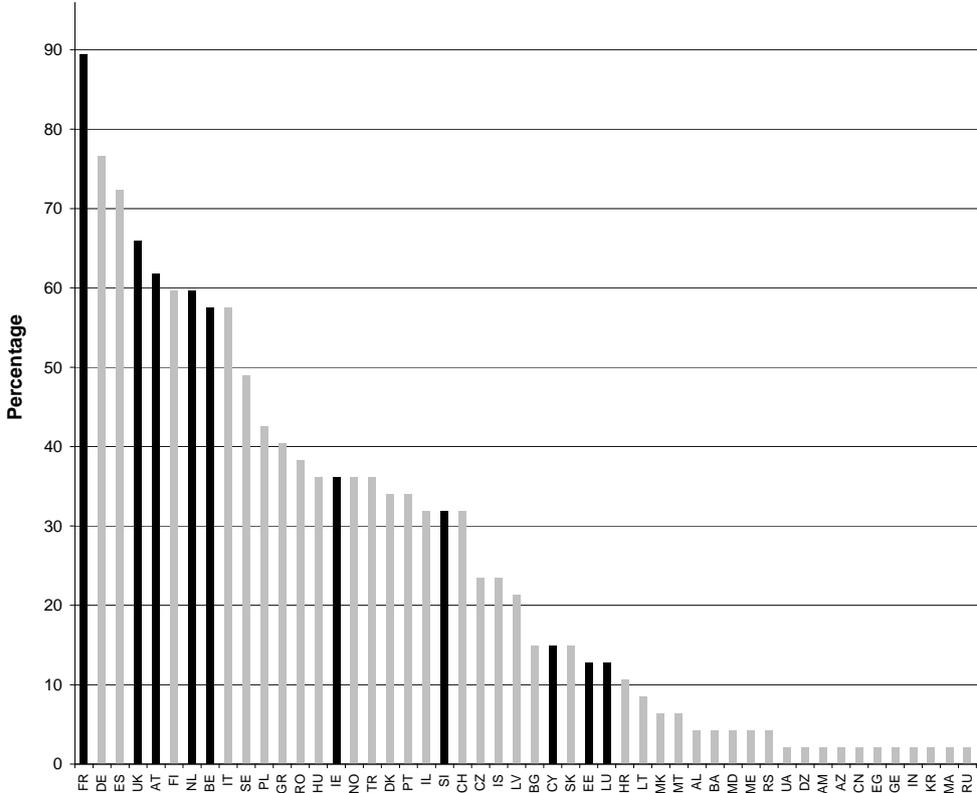
- **National participation in intergovernmental organisations and schemes**

On the one hand, with respect to FP7 success rates (2007 to 2009) about half of the group's countries score higher than the EU average. On the other hand, countries that score below EU average in success rates are mostly positioned in the lowest ranks, mainly due to relatively small country size. This trend of dispersion is even more pronounced when we look at requested Community financial contribution for FP7 calls of the latter (EC-DGRT, 2009:

Third FP7 Monitoring Report). Thus, heterogeneity within the country group in terms of FP7 activities and success is very high. Regarding COST projects (approved actions in 2009) participation share ranges from %5 (e.g., Luxembourg) up to about 90% (e.g., France, the Netherlands and the UK) among countries, again, largely depending on individual country size. On an average, countries in this group join about half of the 60 projects running in 2009.

Similar holds for active participation patterns in EU and international R&D funding networks (i.e. ERA-NETs, ERA-NET plus, Article 169/185) as documented in the NETWATCH26 database and illustrated in the figure below: the countries with participation range above average (~30%) have rates of 60 to 90%, while countries with participation rates around (e.g., Slovenia and Ireland) and below average account for about 15 up to 35%. Compared to prospective participation in 2011, Estonia is the only country in the cluster significantly increasing active participation in terms of rank, shifting from 29th to 23rd position. All other countries either stay in same positions/rank (France, Belgium, Ireland, Luxembourg) or experience only very moderate rank changes (+/-2) in 2010-2011, i.e. moving to lower (Austria, Cyprus) or higher ranks (Netherlands, Slovenia), respectively.

Figure 1. Country participation of innovation followers in international research and funding networks, 2010 (i.e. ERA-NETs, ERA-NET plus, Article 169/185 and other networks)



Source: [NETWATCH Mapping and Monitoring: First Report](#) (N. Harrap and N. Özbolat)

²⁶ For further details please see the NETWATCH Mapping and Monitoring: First Report, IPTS, 2011.

Country shares in coordination roles of ERA-NETs suggest that France is one of the top coordinators across all Europe (2nd after Germany in 2010 and ranked the first in 2011). However, many other countries in the cluster hold coordinator roles. In this way, the cluster of "innovation followers" itself accounts for more than 50% of the coordinator roles in these networks in 2010 and on-going 2011. With respect to specific participation in Article 169/185 schemes, about half of the countries are active in (the maximum) 3 of such networks, while the other half only joins 2 of them.

- **Bi- and multilateral agreements with other ERA countries**

Bi- and multilateral S&T agreements are seemingly an important policy concern in all cluster countries. However, the chosen level(s) of governance and the degree of thematic focus of such cooperation seems to depend largely on the general approach of S&T and economic policy, i.e. a national preference for bottom-up (in the following denoted as subgroup I) or top-down (denoted as II) mechanisms. From the evidence given in country reports, partnering ERA countries are often selected on the basis of a) geographical proximity and/or, b) on the basis of relatively higher quality of the science system, e.g. UK and France, and c) in the case of a common national top-down approach to S&T (II), according to joint strategic, and, hence, thematic interest, and/or d) establishing bilateral agreements/integrative efforts directed towards MS that more recently joined the EU, e.g. Eastern European economies.

Content of such agreements and related implementation efforts, however, largely vary. Some agreements are finalised on the basis of memorandum of understanding (MoU), with only limited mobility provisions exchange programmes and/or co-financing joint research of limited scope, if any. More ambitious, bilateral activities are concerned with the creation of parallel thematic research institutions, mutual agreements on cooperation with third countries and/or or educational and S&T cooperation among economic regions (e.g., as with the Nordic-Baltic blocks). In addition, whenever bilateral cooperation is an established issue of S&T international policies, agreements are signed and maintained on various levels of S&T governance, i.e. simultaneously across national/ministerial, regional, research organizational and individual researcher levels (e.g., in the UK). In contrast, some countries limit agreements to cross-boarder regional levels or MoUs among national ministries and/or academies of science. In other countries, bilateral agreements are run under a mechanism of a single framework programme and/or a single national public agency, as is the case for example in Slovenia and Luxembourg. The countries where no such bundling is in place, or it is only emerging or the national approach to bilateral agreements within ERA is currently under revision, consider leveraging their efforts by enhanced activities in ERA-NETs as well as joint programming schemes on EU levels (e.g., Ireland and Austria). Often existing bilateral ties and implemented agreements in these countries are regarded as a means to improve national performance in EU schemes such as FPs.

- **Opening up of national R&D programmes**

Documented evidence in country reports on opening up of national programmes is scarce or often lacks detailed information. However, country reports indicate recent changes of policies or on-going public debate in many countries (e.g. in Ireland, UK), but outcomes are relatively poor in all countries. There is a weak trend towards opening up of innovation funding schemes targeting industrial partners such as clusters or competence poles etc., which adds to the sometimes observed preferential treatment of early career scientists. However, language requirements as well as a lack of regulation in favour of researcher mobility may hinder successful opening up in the long run/in the first place. Still, in a majority of countries territorial principles apply, i.e. applicants for funding (business or academia) must either have national legal status/affiliation and/or reside in the home country, e.g., the latter implying non-portability of grants. An exception to these rules is often only permitted whenever context-specific advantage to the national economy can be justified accordingly. In addition, the principle of non-discrimination of foreigners frequently in place does not differentiate among individuals or organizations from EU-MS or elsewhere in the world.

Funding in a variety of national public schemes is commonly not available or is limited with regard to non-national researchers or research organizations of other MS residing abroad, being eligible for only 20% up to 50% of funding. In addition, in some countries, additional benefits, e.g., measures of withholding taxes for private researchers at PROs and universities also apply to non-national institutions located in other MS.

MODERATE INNOVATORS

The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below the EU27 average.

- **National participation in intergovernmental organisations and schemes**

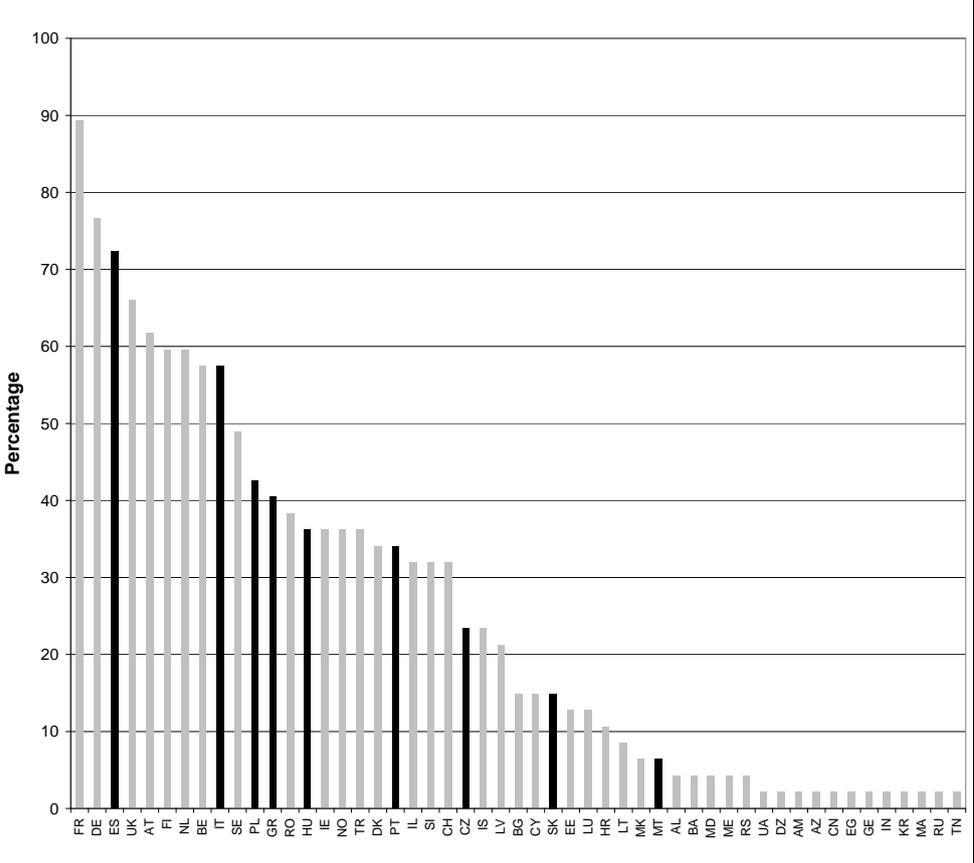
Regarding success rates in FP7, all group countries are slightly below EU average (21.2%), participation rates ranging from 17 to 20% in calls concluded 2007, 2008 and 2009. This reveals a fairly homogenous picture. In terms of national FP7 Community contributions the range is slightly more dispersed, from 11 to 17%, but somewhat below EU average of approximately 20%.

With respect to engagement in COST actions in 2009 we observe relatively weaker (but nevertheless strong) differences among countries compared to the group of "innovation followers", as some account for only 3% while other countries participate in 80% of overall 60 projects. The mean participation among moderate innovators is 43%.

In contrast, participation in EU and international R&D funding networks (i.e. ERA-NETs, ERA-NET plus, Article 169/185) is fairly dispersed, Spain and Italy joining more than 70%

respectively 60% in 2010 as documented in the NETWATCH²⁷ database and illustrated in below figure, while Slovakia and Malta participate only in 5-15% of active ERA-NETs. All other countries in this group range around 30 to 35% rate of participation. Compared to prospective participation in 2011, Portugal and Hungary are the only countries in the cluster significantly changing the participation rank, i.e. shifting from 19th to 12th (respectively 14th to 19th). All other countries either stay in same positions/rank (Spain) or experience only very moderate rank changes (+/-3) in 2010-2011, i.e. moving to lower (Slovakia, Czech Republic, Greece, Poland) or higher ranks (Italy, Malta), respectively. In addition, cluster countries only account for 13% (18%) of available coordinator positions in ERA-NETs in 2010 (2011). Spain and Portugal have only started to engage as coordinators in 2011, while Italy (ranking 3rd in 2011) and Greece have slightly increased their coordinating activities during the period. With respect to specific participation in Article 169/185 schemes, about half of the countries are active in (the maximum) 3 of such networks, while the other half either only participates in 1 or 2 networks, i.e. Malta or Czech Republic, Greece and Slovakia, respectively.

Figure 2. Country participation of moderate innovators in international research and funding networks, 2010, i.e. ERA-NETs, ERA-NET plus, Article 169/185 and other networks



Source: NETWATCH Mapping and Monitoring: First Report (N. Harrap, N K Özbolat)

²⁷ For further details please see the forthcoming NETWATCH Mapping and Monitoring: First Report, IPTS, 2011.

- **Bi- and multilateral agreements with other ERA countries**

Documented evidence on both, bi- and multilateral agreements and opening up of national programmes among "moderate innovators" is scarce or often lacks detailed information. With respect to the former, existing scientific and cultural agreements seem to focus on the domain of academics, ease of access to international infrastructures and often involve inter alia mobility schemes. Less often mobility support is complemented by accommodation and subsistence allowances or seldom joint research schemes. Agreements are likely to be either very specific or remain very broad (i.e. likely underspecified) and under-/or not provisioned with public budget. Selection of partnering countries is heavily biased by geographical proximity. However, given strategic policy interest in expansion of bi- and multilateral activities exists²⁸, there is a weak trend towards increasing engagement in joint operations in S&T by means of ERA-NETs and/or joint calls on EU levels. Anyhow, the overall level of bi- and multilateral research and exchange activities from limited agreements and related public budget commitments is relatively low.

- **Opening up of national R&D programmes**

Opening-up of national R&D programmes is not a concern of S&T policy in all countries (e.g., in the Slovak Republic and Malta). However, in many other countries national programmes are open to participation (without funding) of non-national researchers, research organizations or foreign firms, given the latter have an affiliation to a national institution and reside in the national domain. Other sources of information²⁹, however, suggest that purely open R&I programmes among moderate innovators account for less than 10%, whereby 2/3 of these provide also funding (see below figure). In general, firstly, publicly funded research of nationals or non-nationals must be carried out in the national domain and research grants cannot ex post be transferred abroad in none of the countries. More than half of the countries have implemented mobility schemes, in particular, with respect to brain gain initiatives of national-born researchers based abroad, and treat foreign-born early stage researchers and, in a few places, research subcontractors preferentially. "Preferential treatment" allows for deviation from either territorial principle or legal status requirement of national funding. In this way, despite these efforts, the share of foreign researchers in national domains remains relatively low among "moderate innovators".

²⁸ This is often documented by the fact that countries are recently developing a strategic approach to their bi- and multilateral design, or otherwise attempt incorporation of bi- and multilateral aspects into overarching S&T framework strategies on national level.

²⁹ For further details please see van Bavel, R., de Dominicis, L., Fernández-Zubieta, A., Henriques, L. and Mulatero, F. (2011), *Progress in ERA Policy Implementation Report 2011 "Zero draft"*, and De Dominicis, L., and Henriques, L. (2011) on *Opening-up of national research and innovation programmes in EU-27*

MODEST INNOVATORS

The performance of Bulgaria, Latvia, Lithuania and Romania is well below the EU27 average.

- **National participation in intergovernmental organisations and schemes**

Overall, the participation of these countries in international programmes is increasing, but it is still not satisfactory. This reflects limited international competitiveness and low research potential. The ability to attract international funds is not constrained only by the low level of the national public research system, but also by lack of the administrative capacities. The low level of prior network connection, poor science base, scattered priorities, lack of experience of national institutions, complemented by the limited support offered in the preparation of proposals are among weaknesses that lead to mediocre results in FP7 competitions.

Involvement in inter-governmental European research infrastructures is also restricted by budgetary constraints.

- **Bi- and multilateral agreements with other ERA countries**

All the countries have signed a number of bilateral agreements with other ERA countries. However, bilateral cooperation in research has not been encouraged by active governmental policy or have specific funds allocated. Often, the bilateral agreements based on Memorandum of Understanding did not lead to financially significant, long term research programmes.

- **Opening up of national R&D programmes**

The national research funding programmes have traditionally been closed and largely remain closed to foreign R&D institutions, while foreign citizens from other EU countries can apply for research positions funded under the national programmes. The applicants, should be normally located, have a position in a national institution in order to be eligible.

The opening up of national R&D programmes has not been addressed as an important policy option, as the primary aim of the national R&D strategy and funding instruments is to support the underdeveloped national science base.

BUILDING WORLD-CLASS RESEARCH INFRASTRUCTURES

INNOVATION LEADERS

Denmark, Finland, Germany, Sweden all perform well above the EU27 average.
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With regards the Research Infrastructures (RI), the Scandinavian countries seem to some extent more clustered together, Germany having an out-standing performance, while Finland underperforming. All the countries, but Finland, have some large RIs of international interest. Among the Nordic countries there is also a tradition of cooperation, such as the [Nordic Optical Telescope](#) (NOT), the Nordunet data network and the [Nordic DataGrid Facility](#) (NDGF) for high performance computing. A comparison between Nordic countries indicates that in 2009 Denmark spent €76m, Sweden €87m, Norway €159m, while Finland €130m on RIs. As a consequence of the long term absence of a national strategy and decentralised RI policy, Finland has preferred using RIs abroad rather than developing national ones. In all these Scandinavian countries a National Roadmap for RIs was formulated and it is currently at different stages of its implementation (Denmark - 2010; Finland - 2009; Sweden- 2006). The establishment of ESFRI has been perhaps one area where ERA has had a significant influence in Finland, in the process of establishing a centralised national research infrastructure policy. In Denmark, although the roadmap has just been recently elaborated, there was a step wise development, starting in 2006 with the National Programme for RIs. Given the size of these countries, all the national RIs strategic plans highlight the importance of Nordic cooperation for the development of Nordic infrastructures and of the national contribution to ESFRI. Examples of the later include the joint Nordic Nordsyn consortium within the European Synchrotron Radiation Facility (ESRF) infrastructure and the Facility for Antiproton and Ion Research (FAIR) project. All the Scandinavian countries contribute to European Strategic Forum on Research Infrastructure (ESFRI) projects (Denmark in 12 projects, Finland to 5, while Sweden contributes to 15 out of the total 35 projects). The national participation in ESFRI is coordinated with the developments of large RIs at national level.

Germany with its long tradition in hosting various large scale RIs of international importance and consistent, long term investment in research facilities stands out and has different policy approach. The internationalisation strategy highlights the importance of opening up to international researchers the RIs hosted nationally, having the top position concerning the utilisation of RIs by foreign visitors. Germany often is one of the founding members of large inter-governmental RI, few of them emerging from bilateral relationships between Germany and France (i.e Institut Laue-Langevi, ILL), while some are/will be located in Germany. Several projects of the ESFRI-roadmap are being coordinated by Helmholtz centres. Projects with German participation and joint coordination include the construction of HALO (the High Altitude and Long Range Research Aircraft), the High Magnetic Field Laboratory Dresden

(HLD), and the experimental nuclear fusion reactor ITER, FAIR (Facility for Antiproton and Ion Research), DESY in Hamburg, the high-brilliance synchrotron radiation source PETRA III, the X-Ray Laser Project XFEL is currently under construction in Hamburg.

INNOVATION FOLLOWERS

Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK all perform close to the EU27 average.

80 % of these countries have relatively large RI in place with the main rationale of creating critical mass as well as competitive advantage in specific scientific fields. Anyhow, up-to-now, only 70% have an explicit roadmap for building new RIs, even though (present and future) scientific demand seems high in almost all countries and infrastructures are likely to outlive initial, shorter-term project financing. The RIs are dedicated to physics, astronomy, energy, bio- and nanotechnology related material, medical as well as chemistry and ICT sciences. Prospective investments also include humanities and social sciences. In a few countries, maintenance is secured by EU's structural funds additional to (initial) national public funding efforts. In this way, some country experts suggest that, to some extent, it becomes increasingly difficult to clearly separate overlapping national from joint or inter-governmental research infrastructure with respect to access and longer-term maintenance, as, in particular, national RI strategies are getting aligned with international ones in many cases.

Rough national estimates of the public investment share, i.e. the share of GBOARD, in research infrastructures highlight that this ranges between 5 up to 20% among "innovation followers". Investment shares have been increasing in the last couple of years in most countries, but these attempts were cut back due to the crisis.

In a few countries, involvement in the European Strategic Forum on Research Infrastructure (ESFRI) has triggered writing RI strategies on national levels, e.g., in Estonia, as well as their increasing alignment with international activities. Patterns of participation in ESFRI are heterogeneous among countries according to the size of their economies and research systems. One exception is Cyprus which does not participate. However, in most places, about half up to two thirds of national financial commitments to ESFRI projects were still pending proposal decisions (at the time country reports were written) or have been fully suspended, again, mostly due to the crisis.

MODERATE INNOVATORS

The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below the EU27 average.

A large majority of the countries among "moderate innovators" have established large research infrastructures. Some of the countries do not have an explicit roadmap for building new RIs or public consultation is only underway, while a smaller fraction of countries have already outlined strategic roadmaps. Development of strategic roadmaps has led to nationwide consultations among major funding institutions and the user community, the latter involving, both, private and public actors. In this way, rationales for establishment and thematic selection of new infrastructure seem largely based on considerations of having European RI significance (which will qualify for prospective funding), strengthening and quality improvement of the national science base as well as RI supporting specific national industrial research of strategic importance. Current thematic focus is mostly in physics, astronomy, energy and nanoscience fields. In a few cases, established RI quality and maintenance suffer from fragmented and uncoordinated public governance that restricts RI investment and strategic planning to randomly successful, small-scale bottom-up initiatives by research groups.

As far as country experts have documented information and large national RIs have been established (approximately 50% of the country group), national RI investment accounts for 3-10% in GBOARD shares, mostly this being based on 2008/2009 estimates or prospective outlays 2009-2015. Even though this share has been increasing in the recent years in most countries, heavy budgets cuts in national RI investments are expected. In many countries, current RI investments and maintenance involve large shares of EU structural funds or "intentionally" overlap with international ones in order to benefit from other forms of EU co-finance.

As, evidenced within the group of "innovation followers", the European Strategic Forum on Research Infrastructure (ESFRI) has triggered the design of national RI strategies and related national consultations among all stakeholders. Anyhow, there are also very few countries within this group unwilling and/or unable to fully participate in ongoing ESFRI's work (as the Slovak Republic), but e.g., limit participation to preparatory stages (as Portugal). This is often due to absence or crisis impact on budgetary means or the ESFRI concept itself being perceived as an unsatisfactory framework with respect to precise definitions of targets and means/milestones for RI development. In general, in many cases decisions on national participation in ESFRI have been postponed and credibility of commitments suffers from budgets not being specified. However, on an average, countries are likely to engage in about a quarter up to half of the projects while the share of projects involving national commitment on funding is much lower.

MODEST INNOVATORS

The performance of Bulgaria, Latvia, Lithuania and Romania is well below the EU27 average.
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National Research Infrastructures roadmap

The design and implementation of the National Roadmap for Research Infrastructure is at different stages in these countries: Romania had launched it in 2008, Lithuania has reserved national public funds for new RIs as a result of two extensive reviews carried out in 2007, in Bulgaria it was drafted but still lacks funding, while Latvia is one of the very few countries not having initiated the process of drafting it, yet, certain developments could be identified.³⁰ In Lithuania the investment the National Roadmap for RIs was accompanied by significant organisational changes in the PROs, the highly fragmented network of research institutes undergoing restructuring in 2009-2010. Overall, it can be assessed that the countries lack financial support and political commitment to the policy goals and the science base remains obsolete.

National participation in ESFRI

The National Roadmaps for Research infrastructure identify national priorities in the frame of the available inter-governmental research infrastructures and the planned ones. The participation in ESFRI is limited by financial constraints. Romania has the largest participation, being currently involved in 9 of the 36 ESFRI.

KNOWLEDGE TRANSFER

INNOVATION LEADERS

The performance of Denmark, Finland, Germany, Sweden is well above the EU27 average.
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- **Intellectual Property Policies (IPR)**

In the innovation leaders group, ensuring exploitability of research results is an important feature of the Research and Innovation system. Although patent law and other IPR regulations have been established for a long time, they have been much debated in recent years and consequently in all the countries have been recently evaluated/ revised. The revised regulations (Denmark: 2002, Finland: 2006, Germany: 2002) shifted the ownership of research results from academic researchers to their home institutions. Under the new regulations, the institutions are entitled to claim the IPR for inventions made by their researchers, while the researchers are obliged to disclose inventions to their organisation and receive a reasonable royalty payment. In Germany, the university has four months to decide whether to patent the invention or not. If the HEIs decide to patent the invention, the researcher receives for the awarded patent a compensation of 30% of the gross income, while the so-called Patent Commercialisation Agencies (“Patentverwertungsagenturen” - PVA) are

³⁰ http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri-other-roadmaps

responsible for the IPR management. If the HEI decides not to patent the invention, the researcher retains the full patent rights. PVAs were established after 2002 at federal state level, having the scope to manage IP activities for universities within their federal state. They receive some basic funding from federal government programme (SIGNO) but are expected to cover part of their costs from licensing and royalties, which was assessed as unrealistic, since the majority of university patents do not yield significant economic return.

In Sweden, the “exemption for academic staff”, similar to the *University Staff Privilege in Germany* abolished in 2002, is still applicable in university and colleges with regards to patentable inventions. According to this regulation, the researchers have full ownership rights of their research result, if another agreement has not been reached. The Swedish government recently investigated the need for the revision of this regulation, in order to give the right to the universities over the researcher’s patent against a reasonable compensation. The government has decided to keep the exemption but to consider introducing an obligation for the researchers to report inventions to their employer.

In Denmark, since 2004, commercialisation of public research results has been assessed regularly. The 2004 evaluation of the new Act concluded that the change was well received by the HEIs researchers, but the outcome (in terms of increased number of patents and licenses) was modest. A code of conduct for research cooperation between universities and companies was developed. In 2000, the Ministry of Science, Technology and Innovation established five patent consortia to deal with patenting and to increase collaboration between PROs and businesses. However, the assessment indicates that there is room for substantial improvement in the Danish commercialisation system and that the main obstacle in the funding schemes supporting the cooperation public-private is related to IPR.

• **Spin-off**

In all these countries, the creation and support to innovative spin-off and start-up companies is targeted by specific policy measures. In Finland, Tekes and the Finnish Technology Park Association have had since 1993 a dedicated (TULI) programme³¹ for supporting start-ups, spin-offs, technology transfer, and the commercialisation of publicly funded research results. In Germany, the EXIST programme of the Federal Ministry of Economics and Technology support new entrepreneurs from HEIs and PROs who want to turn their ideas into a start-up/spin-off (“*EXIST Business Start-Up Grant*”), while “*EXIST Transfer of Research*” supports the research-based start-up projects involving high risk and complex projects. In Sweden, the *Tillväxtverket* (Swedish Agency for Economic and Regional Growth) is responsible for supporting entrepreneurship, start-ups and the SME development and has a wide range of measures at its disposal.³² Also, the newly established *innovation offices* are intended to support researchers who want to commercialise their research results and to

³¹ In the 2008-2013 period, the programme budget is approximately €50m. In 2009 a total of 748 projects were granted funding for further development. A total of 80 licensing and technology sales were reported with the revenue of €2m to the universities and research institutes.

³² such as: the Innovation Bridge, VINNOVA, the Industrial Fund, University holding companies, Nutek and ALMI Business Partner

establish spin-offs. In Sweden and Germany, recently, stronger emphasis is put on improved regulatory framework and access to venture capital.

Even though in all these countries there are established mechanisms to support spin-offs, the assessment indicates that there is a need for further support and increased venture capital. For example, although spin-off companies are actively founded in Finland, studies indicate that their economic performance is disappointing: among 171 spin-off companies founded in 2000-2005, only one company had an annual turnover over €2m and only 15 companies had succeeded in increasing turnover over €400,000 by 2005. In Denmark, the 2008 public research commercialisation survey pointed out that private investors have become more reluctant to invest in university inventions. Although in Germany recent measures focused more on improving framework regulation, the availability of venture capital is constrained by general corporate tax legislation and has been assessed as still being too restrictive to allow for substantial improvements as only 0.04% of GDP is used for venture capital investments. In addition, since the financial crisis, it has become increasingly difficult to attract private capital for university inventions.

- **Inter-sectoral mobility**

In all these countries, the inter-sectoral mobility faces relatively few formal constraints. Special programmes support mobility and exchanges of scientists between public and private sectors, and overall the inter-sectoral mobility of researchers is high in comparison to other EU27 countries (MORE, 2010). Many doctoral theses are completed in close cooperation with industry or often within industry.

Evidence shows that the inter-sectoral mobility is more common among researchers at the beginning of their career than for senior researchers and professors. The industry does not necessarily appreciate the PhD level education and PhD holders are mostly employed by the public research sectors. In Denmark, although approximately 80% of PhD grants support mobility between universities and companies, only around 20% of PhD graduates get positions in the private sector (DASTI 2007). In Finland, the 2006 programme supporting PhD mobility between the academic and private sector, raised concerns since half of the funding remained unused, while generally the competition for PhD fellowships is very high. As a consequence the scheme was discontinued. However, some other projects to facilitate the employment of PhDs in the private sector have since been initiated, such as 2008 “Tohtoreita yrityksiin (Doctors to Enterprises). In Sweden, according to the government, the inter-sectoral mobility should be further increase and facilitated. Three different possibilities to encourage mobility have been identified: hiring of professors in industry, industry PhDs and the establishment of graduate schools integrating the industry collaboration and innovation. VINNOVA also introduced a number of instruments supporting inter-sectoral mobility of more senior researchers.

- **Promoting research institutions-SME interactions**

According to the R&I figures (HERD and GovERD financed by private sector) the cooperation between the business sector and public science is still fairly weak in Denmark and Sweden, enterprises only finance the national public R&D to a minor degree, while in Finland, the business sector plays a higher role. In Finland and Denmark the research, higher education and innovation policies are fairly well coordinated, while Sweden has a disparate governance system.

In Denmark, the main instrument facilitating the interaction between public R&D institutions and SME are the Knowledge and Research Vouchers for SMEs. In Finland, more than 50% Tekes funding is allocated to SMEs (Tekes, 2008), with a high share of these funds supporting in-house R&D. Significant funds support also collaborative R&D projects or research services provided to SMEs. In Germany, the exploitability of the research results is a quality criterion for a number of public R&D support measures, mainly the pre-competitive programmes of BMBF and BMWi.

Sweden features some distinct particularities. The Swedish paradox highlights the inadequate return on public investments in R&D. Most of the policy measures supporting collaborations between industry and academia, are open also to the SMEs, yet the number of measures specifically targeting SMEs is limited.³³ Most of R&D input comes from few large multinational companies (MNC) and to a lesser extent from SMEs. This imbalance may be aggravated by the crisis which is more likely to negatively affect R&D investment from SMEs. On the other hand, increasing globalisation and competition promoted MNCs to reallocate their R&D investments abroad. The entrepreneurial climate in Sweden remains relatively poor in comparison with many other European countries. In the new research bill “A boost to research and innovation” 2008/09:50, a number of policy changes are proposed to help redress this imbalance. Policy instruments promoting the establishment of new indigenous R&D performing firms include increased provision of venture capital, especially in the early stages of the innovation processes, the strengthening of Intellectual Property Rights (IPR) and a new initiative to establish ‘innovation offices’ at the major universities.

Although support measures are in place to support the private-public research collaboration, they are assessed as insufficient or inefficient, with a need to further strengthen and develop interactions between research institutions and SMEs.

- **Knowledge Transfer Offices**

In all these countries, specific funds are dedicated to the creation and/or reinforcement of the Knowledge Transfer Offices, yet it could be assessed that increased financial and policy efforts are needed.

³³ The main actors in the Swedish support system for innovative starts-ups and entrepreneurship are: the Innovation Bridge, VINNOVA, the Industrial Fund, University holding companies, Nutek and ALMI Business Partner.

In all the countries the universities reform introduced the new model of governing boards, which must have members from industry and business. The external members are often in the governing boards of the PROs.

- **EU cohesion policy**

In all the countries, one of the main aims of the ERDF programmes is to support the cooperation and networking, particularly between public and private R&D actors. The importance of creating more competitive regions, regional clusters of expertise has received increasing attention partially because of the EU's Cohesion Policy and available ERDF funding are directed to measures in accordance with these priorities.

INNOVATION FOLLOWERS

Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK perform close to the EU27 average.

Most national knowledge triangle policies have been expanded in the ultimate years. Often they do not only follow goals of bringing together private and public research and innovation actors in collaborative terms, but also have complementary goals co-existing. The latter include regional development objectives or maybe targeting specific actors in specific fields being theme, excellence or early-career-stage driven. In a few countries, coordination and transfer between private and public R&D activities is relatively easier due to country size and smaller number of HEIs, PROs and businesses involved. In others, knowledge triangle policies have had high STI priority from the very beginning as relatively new R&D systems are only emerging, requiring consistent R&D input over time.

There is a general trend towards additional knowledge transfer policy instruments targeting close-to-market/downstream stages of R&D rather than early research stages, e.g., support for prototype building at universities, involving a stronger emphases on knowledge transfer related finance by establishment of university funds or joint PP fund-raising schemes. Depending on the specific country's industry structure, given public-private partnerships target services sectors, in a few countries, the output often resembles in consultancy rather than research.

In addition, another policy trend seems to lead in some places to a vital policy interest in relative changes in ex ante funding structures because of their potential impact on the knowledge transfer (e.g., competitive funding by businesses) as well as the establishment of PROs active in applied sciences changing the institutional R&D landscape. However, on the one hand, most country reports still document a dominant pattern of block/institutional funding, likely to hamper the overall role of knowledge transfer in national R&D systems. On the other hand, block/institutional funding is regarded as a prerequisite for (maintenance of) quality of the knowledge base which may, in turn, limit policy interest in these changes.

In a few countries, individual researcher's incentives are limited as public-private collaboration success has only limited relevance for promotion and careers as well as there is an enhanced emphasis on scientific excellence rather than "innovation excellence". In addition, there is a limited/low relevance of public research units for innovation activities of enterprises relative to other sources of knowledge and limited visibility of public funding schemes. Some country experts express their concern on missing policy impact assessment practices, the cumulative effect on knowledge circulation remaining unclear, partly due to the newness of some measures in place.

MODERATE INNOVATORS

The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below the EU27 average.

All countries within the cluster have in place a set of instruments supporting the knowledge transfer. However, these sets vary in terms of elaboration and broadness.

Some country reports evidence knowledge transfer policies mostly in the context of other innovation or regional policies, e.g., openness of direct funding in R&D programmes to private as well as public actors, or as part of more general collaborative research schemes. Cluster and transfer intermediary policies such as the establishment of technology parks and KTOs at HEIs and PROs, respectively, can be found among all countries within the sample. These "classic" instruments have been expanded recently to SME-focused innovation vouchers, legislative change fostering student or researcher mobility, close-to-market product development grants and academic spin-off policies in some countries. In others, some of the policies in this specific field have been fine-tuned with EU level initiatives, most likely due to either funding requirements or rent-seeking behaviour among MS. In addition, there is a more or less pronounced trend on creation of policies that target getting ideas to the marketplace by supporting, e.g., proof of concept stages of innovation.

Some of the relevant instruments suffer effectiveness due to limited absorptive capacities of the businesses sector. However, e.g., not all of these countries have SME specific support schemes in place to overcome structural features of economies, even though recent policy changes try to account for systemic failure. In other situations, STI policies are less able to put an emphasis on knowledge transfer due to an institutional funding focus or researchers facing the trade-off with requirements of excellence-driven science. However, as the majority of countries lack scientific excellence or evidence on explicit excellence policies is limited, the importance of the latter trade-off is disputable. In a very few countries overall funding allocation (ex ante) has been altered in favour of PROs of applied science, with the purposes of empowering technology transfer (ex post).

MODEST INNOVATORS

The performance of Bulgaria, Latvia, Lithuania and Romania is well below the EU27 average.

- **Intellectual Properties policies**

The legal system regulating IP rights may be arguable assessed as one of the bottlenecks in the exploitation of knowledge generated by the public research system. In addition, the strategies for IP management and knowledge transfer are vague. Knowledge Transfer Offices (KTOs) are rare and if they exist they are not fully operational due to the lack of interest from the administration of PROs' and HEIs' and lack of competent IP management specialists in the country. Technology transfer activities to business are relatively limited, due also to a low demand from industry and also a relatively weak offer from public R&D performers.

- **Spin-offs**

There is no tradition of 'spin-off' in these countries and the practice is still limited. The support systems facilitating knowledge transfer from universities to the economy are in an early stage, therefore the creation of spin-off based on recent research results, patents or licenses is a slow process, which has been further hindered by the lack of capital and difficult access to bank financing determined by the economic crisis. Some measures have been recently designed and are currently implemented within Operational Programmes financed through SF. Framework conditions for private investment in R&D are underdeveloped, especially in terms of fiscal incentives and other financial instruments aiming to facilitate access to private finance. The general business environment is regulated by a variety of laws and legal provisions that are sometimes far from simple and transparent, and their enforcement is often poor.

- **Other policy measures aiming to promote public-private knowledge transfer**

A few policy measures in the knowledge triangle domain exist, yet they are perceived as underdeveloped or have been postponed and underfunded due to the crisis. In addition, all measures have been introduced only recently, hence, the evaluation of their impact is not yet available. These measures include R&D collaborative private – public funding programmes, development of innovative clusters and science parks.

All these countries have very low levels of BERD, despite the public push. Although the complexity, coherency and coordination of the schemes designed to support the private R&D differs from one country to another, the low capacity of private firms to absorb R&D funds is a common pattern. The main instruments aiming to have a leverage effect on business R&D expenditure build on SF and consequently follow EC recommendations regarding the evaluation and monitoring procedures. Yet, the results remain low and the slow to achieve. Several reasons may be considered for this. On one side the private companies may be

reluctant to participate in these schemes. This could be triggered by complex application procedures, high bureaucracy or fear of well-established and well-known defective routines and evaluations, often showing political or other sort of favouritism, as is the case of Bulgaria and Romania. On another side, the enterprises may hesitate to increase their competitiveness based on RDI activities because of high market risks and technological uncertainties, particularly true in unstable economies and oriented towards low and medium technologies.

Demand side policies such as innovative public procurement are underdeveloped or very preliminary, being at informational and learning stages.

One of the main challenges of the private sectors in these countries is not the R&D itself but rather the need of technological update in order to approach the Western European level of innovation. The low patenting activity is then rather a reflection of the economy sectoral distribution, low R&D input, the specificity of the catching up economy and its NIS rather than of the capability of researchers to produce exploitable performance. Often knowledge transfer, collaborative projects and IP commercialisation activities of HEIs and PROs are driven by the availability of public funding, and not by market pressures and opportunities. Overall the macroeconomic situation, the structure of the economy, the overall entrepreneurship culture together with the intensity and type of competition creates a context in which the STI policy schemes, however well designed and implemented may not be able to offer strong enough incentives to overrule the unfavourable framework conditions.

There are no formal restrictions on mobility of research staff between the public and the private business. However, examples of such mobility are rare, mobility being primarily towards foreign research units.

INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION

INNOVATION LEADERS

Denmark, Finland, Germany, Sweden all perform well above the EU27 average.
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In all this cluster countries, the international R&D collaboration with third countries is seen as an important target, yet generally it can be assessed that although the internationalisation is well developed further efforts are needed to strengthen the international dimension of research. Various instruments are used to facilitate the collaboration with third countries, under various legislative regulations and organisational frameworks.

In Denmark, the Danish Research Coordination Committee, dissolved in 2011, had a specific role in the promotion and coordination of international research collaboration. The Danish

funding organisations have the strategic focus on joint financing and researcher mobility, but are subject to different legislations and therefore offer different levels of funding for international activities (Danish Research Coordination Committee, 2010). In Finland, the collaborative agreements are managed by the Academy of Finland and Tekes. The international cooperation in fields where Sweden can exploit its comparative advantages is one of Sweden's strategic priorities and various bilateral agreements serve this purpose. In Germany, the strong international perspective is one of the commitments made in the Pact for Research. The international scientific cooperation is co-ordinated by the International Bureau of the BMBF and supported by a web-based signposting and information service³⁴ () and the Internet portal³⁵ (), which provides foreign researchers and scientists with information about research opportunities in Germany.

The most common instruments for R&D cooperation in specific S&T fields are the bi/multilateral agreements with third countries that demonstrate strong capabilities in those fields. These agreements may be between governments, or agreements on research cooperation between national and third countries' research funding bodies and research organisations. Denmark actively collaborates with Israel (with focus on biotechnology and ICT), China, India (biotechnology) and Japan (life sciences). Germany has bilateral agreements on cooperation in education and research with more than 50 countries³⁶. Sweden actively collaborates with Brazil (bioenergy and biofuels), India (life sciences, IT, environment, transport), Israel (IT), Japan (Biotechnology, ICT, e-Health), China (material, ICT, biomedicine, research and innovation policy, environment, energy and climate change, healthcare), South Africa, USA (several different fields with a focus on renewable energy). The Academy of Finland has bilateral agreements with 16 countries, while Tekes has also collaborative partnerships with several countries, such as the USA, Japan, China, Canada, Israel, Singapore and Korea.

Another tool used to enhance the international collaboration with third countries are the innovation centres established in leading research, innovation, and industrial communities outside the ERA. Such an example are the innovation centres established by Denmark in Shanghai (China) and Silicon Valley (USA), the foreign offices established by Sweden in third countries to support the R&D collaborations and the joint university centres (i.e. Danish-Chinese University centre in Beijing, Max Planck institute in USA - Max Planck Florida and Fraunhofer Project Centre for Biopharmaceutical Research in South Korea).

A number of initiatives are in place to increase the mobility of researchers, but most programmes do not distinguish between foreign researchers from ERA-countries and non-ERA countries. Exceptions are funding programmes designed in a bilateral agreement with a third country

³⁴ <http://www.kooperation-international.de/en>

³⁵ <http://www.research-in-germany.de>

³⁶ Further information can be found on <http://www.bmbf.de/en/707.php>

INNOVATION FOLLOWERS

Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK all perform close to the EU27 average.

Many of the countries are active in the field of international S&T cooperation by means of bi- and multilateral dialogue. This includes information exchange, exploratory expert mission, export promotion, full-fledged R&D cooperation (including joint funding) or cross-boarder knowledge exploitation. However, not all countries have explicit long-term strategies on international S&T cooperation in place as emergence of an explicit strategy often seems to require coordination across national policy domains, e.g., foreign affairs, industrial/trade policy, development and education policy, or is sometimes hindered by fragmentation of national STI governance. In addition, activity in this field is of minor importance (in terms of public R&D budgets dedicated) as compared to intra-European collaborative activities. If a strategy (or strategies) is in place - as in a few more advanced countries -, it is frequently launched on many different levels at the same time, i.e. including national, regional, HEI/PRO and individual researcher levels. This, in turn, does not necessarily create an overall coherent picture/set of strategies. In general, evidence-based, strategic selection of partnering third countries and long-term commitments of national public R&D budgets is still the exception among these MS. In this way, country reports often highlight expected cuts of ad-hoc budgets in the near future due to the crisis. Similar holds for the integration of/orientation towards global challenges as an objective of such cooperation, i.e. there is no or very limited evidence. Anyhow, this does not mean there is no thematic drive in S&T cooperation with third countries in general. There is indeed a focus on creating critical mass on outputs or attraction of human resources (input-related) in specific scientific areas, often of joint/bilateral interest. In a similar fashion, thematic focus in cooperation with third countries frequently reflects national STI priorities and national competitive advantage.

Targeted third countries for the S&T cooperation are mostly determined by the following motives - in order of their relative importance:

- 1) geographical and cultural/lingual neighbouring, i.e. Mediterranean or Eastern European/Balkan, non-MS countries or accession candidates,
- 2) on one hand industrialized countries with high and established R&D expertise and economic power such as the US, Japan, Canada or Australia, and, on the other hand, BRICS-emerging economies, and lastly,
- 3) smaller non-BRICS Asian or South-American countries, e.g., South Korea, Argentina or Vietnam, and developing, mostly African countries.

With respect to mobility schemes the evidence suggests that "innovation follower" country strategies are really twofold. There is a group of MS (in the following, denoted as group A, including e.g., the UK, Ireland, Austria and Slovenia) that focuses on attraction of (young) talent from third countries, not necessarily based on bilateral but often unilateral mobility

schemes in favour of third-country citizens and national system. There is another group of countries (denoted as group B, e.g., Netherlands, Belgium) highlighting the importance of reversing the outcomes of past brain drain, i.e. re-attracting national researchers abroad, mostly based on unilateral schemes. One exception is Luxembourg which has a traditionally high share of foreign-born S&T human resources, the majority from neighbouring countries but also non-EU citizens. Countries in subgroup A often largely have enforced or are about to enforce favourable work permit requirements (comparable to the ones offered to scientists from EU MS) in order to facilitate stays of foreign-born researcher. In addition, mobility schemes in A focus on various aspects such as specific scientific fields (e.g., medical research), different levels of experience of researchers, targeting scientists that are able to bridge basic and applied science including knowledge transfer abilities, and opening up of schemes that formerly were designed to attract foreign researcher. However, a few country experts express their concerns on overall strategic coherence of such a broad set of schemes, e.g., due to missing joint evaluation mechanisms in bilateral schemes, successful emergence mostly not being based on an initial policy framework. Thematic and country-targeting focus of mobility schemes in countries of subgroup B are frequently reflecting profiles of general national effort on international S&T cooperation with drivers as described above.

MODERATE INNOVATORS

The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below the EU27 average.

Even though a few country reports (e.g. Italy) document the existence of an overall policy framework for international S&T cooperation there is considerable evidence that a share of bi- and multilateral agreements is not implemented and remains at a level of memorandum of understanding with no specific budgets attached or limited to cultural agreements. The latter seems particularly true for countries with a broad set of partnering countries and with no such strategic policy framework in place. Anyhow, whenever joint initiatives are implemented they range from joint research publications, cooperation in education schemes, joint use of infrastructure and data collection as well as in some fewer cases cross-boarder technology and knowledge transfer activities. In this way, cooperation seems to address bi- and multilateral efforts at early research and education/human skills-related stages (i.e. dedicated mostly to HEIs and PROs) more than collaborative, applied R&D and technology stages (i.e. forms of cooperation including firms).

Targeted countries in S&T cooperation on national levels are mostly determined by the same reasons as for innovation followers.

There is no evidence of policy goals and specific concern in international S&T cooperation. The overall thematic pattern of S&T cooperation often corresponds to the national scientific and industrial profile. In very few cases, this also includes global challenges such as health and ecosystems.

With respect to mobility schemes addressing third country cooperation evidence on explicit financial support, e.g. travel pay, in favour of inward mobility of foreign researchers is relatively scarce or at very low levels and focused on outward mobility to specific target-countries. However, in most "moderate innovators" countries none of such schemes exist. Rather, with respect to related national regulation, if favourable work permit requirements, tax and social security benefits for highly-skilled foreign workers (mostly, not focused solely on scientists) were put in place, they were often initially launched on EU levels. In general, these requirements and benefits differ strongly in most cases, in particular with respect to benefits for scientists from EU MS and third countries. Alternatively, in a few countries, efforts on S&T cooperation have been launched at institutional rather than at national level.

MODEST INNOVATORS

The performance of Bulgaria, Latvia, Lithuania and Romania is well below the EU27 average.
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The international cooperation is implemented through bi-lateral agreements (Memorandum of Understanding) which often do not result in actual implementation of research programmes.

Generally, there are no mobility schemes particularly targeting researchers from third countries apart from the projects included in the bilateral agreements. Examples of researchers from third countries being employed in these countries are rare and come mainly from post-Soviet countries.

SUMMARY OF THE EVIDENCE RELATED TO ERA IMPACT ON MS POLICIES

In this section, the relative importance of each ERA dimension is assessed, by analysing the survey responses from ERAWATCH country experts. This may further enrich the detailed analysis of each dimension and country cluster (as highlighted in the 2nd section). In this way, country experts were asked for a general assessment of ERA from a national perspective, bearing in mind their groundwork efforts and large amount of quantitative and qualitative information collected and policy implications presented in ERAWATCH country reports and platform³⁷. In particular, the assessment includes a weighting of ERA dimensions, underperformance of national policies in ERA dimensions and experts' suggestions on the adequate governance level for prospective policy-making in each dimension. More precisely, the experts were asked to give their opinion on the following questions:

³⁷ Most of the responses given in the survey sent to correspondents are consistent with the information given in country reports. However, only in very few country cases, we have detected responses to be seemingly inconsistent.

- *What is the relative importance of the six ERA dimensions on existing policy initiatives in your MS ?* Experts were asked to give the relevant score, using a 5-point scale, ranging from "not important" (1) to "very important" (5) .
- *In which of the ERA dimensions do you think national policies have underperformed over the past 2 years?* Experts were asked to indicate the top three ERA dimensions where the country underperformed.
- *From the perspective of your MS, which governance level should play the most important role in order to make progress along each ERA dimension?* Experts were asked to choose one governance level per dimension.

(a) ERA Assessment across all member states

We begin this subsection by studying the experts' assessments on the relative importance of ERA dimensions, i.e. implications on weighting of these dimensions. Figure 3, illustrates higher (or lower shares) of responses falling in a specific category of importance.

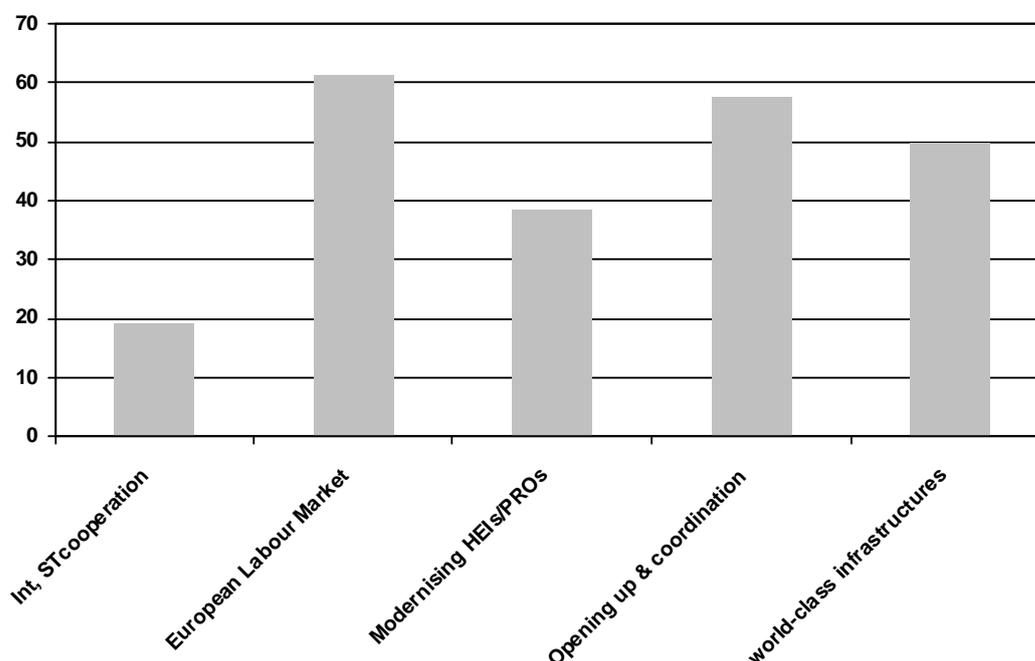
Figure 3 Heat map. Relative importance of ERA dimensions (% of all respondents)

<i>11 ERA dimensions</i>	<i>not important</i>	<i>low importance</i>	<i>of some importance</i>	<i>important</i>	<i>very important</i>
Knowledge transfer	0	7.4	14.8	48.1	29.6
Int. ST cooperation	3.7	7.4	18.5	33.3	37
European Labour Market	0	14.8	37	37	11.1
Modernising HEIs/PROs	3.7	7.4	14.8	25.9	48.1
Opening up & coordination	7.4	37	37	11.1	7.4
World-class infrastructures	0	14.8	18.5	29.6	37

Source: Survey on ERAWATCH country experts, n=27, IPTS (2011)

The most important dimensions appear to be "Modernising HEIs and PROs", "Knowledge transfer", "International S&T cooperation" and "Building world-class infrastructure". Of relatively minor, although not insignificant importance, are the "European Labour Markets" as well as "Opening-up and Coordination" dimensions. We then turn to the extent to which recent STI policies address ERA goals.

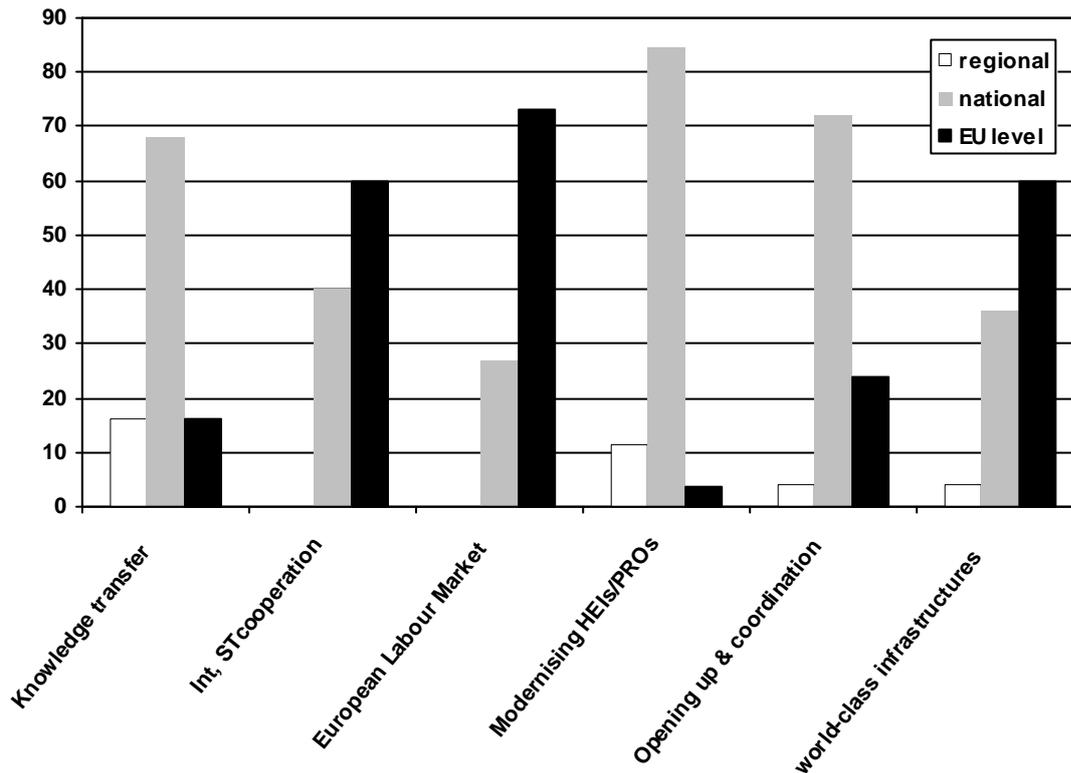
Figure 4. Underperformance of national STI policies in the last few years (% all respondents)



Source: Survey on ERAWATCH country experts, n=27, IPTS (2011)

As highlighted in Figure 4 above, it seems that at national level, less policy emphasis was put on policies related to "European Labour Markets" and "Opening-up and Coordination". In this respect "World-class infrastructure" ("Modernising HEIs and PROs") related policies rank third (fourth, respectively) according to the expert assessment. Given the differences in the relative importance of these four dimensions (taking into account implications from above heat map), lack of national policy focus failure or underperformance of related instruments is likely to hinder developments in the ERA context to a fairly similar extent. In any case, they may serve as an early warning signal for national policy-making efforts and future allocation of effort and coordination on EU level. In this way, it is also interesting to study which governance level to address on future STI issues in relation to ERA progress.

Figure 5. Adequate governance level suggested by correspondent network (% all respondents)



Source: Survey on ERAWATCH country experts, n=27, IPTS (2011)

Experts do not necessarily agree on a specific level of governance, ideally introducing and implementing next steps in a dimension. E.g. national experts call for exclusive action on EU levels, in particular on "European Labour Markets", but differ in their opinion on "World-class infrastructure" as well as "International S&T cooperation" dimensions. Some of these seem supranational activities by nature or may, at least, offer an opportunity for joint efforts (with national governments). In addition, for "Modernising HEIs and PROs", "Opening-up and Coordination" and "Knowledge Transfer" dimensions, the interventions at national policy level are assessed as the most appropriate. The need for regional governance is assessed as minor by all experts (equal or below 10%).

To sum up, given the assessments on relative importance of ERA dimensions, we are able to identify and prioritize specific dimensions according to the EU-wide assessment. On EU levels, regulatory efforts should focus on: (1) "European Labour Markets", and (2) "World-class infrastructure", given consensus on joint efforts is reached for the latter. On national levels, policies ideally should focus on (1) "Modernising HEIs and PROs", and, (2) "Opening-up and Coordination". These dimensions should be prioritized since 1) the national performance was assessed as poor in the last year, and/or, b) any policy adjustment (EU level, national level or joint effort) in these dimensions may benefit from strong leverage effects.

(b) ERA Assessment among specific country clusters

A similar exercise as above, was performed focusing on country specific views related to the comparative role of ERA dimensions. Results are highlighted in Figure 6. Again, darkness of shading reflects the importance of the specific policy dimension in a specific country cluster.

Figure 6 Heat map. Relative importance among country clusters (% rating "important" or "highly important" within cluster)

<i>ERA dimensions / country clusters</i>	<i>Innovation Leaders (1)</i>	<i>Innovation Followers (2)</i>	<i>Moderate Innovators (3)</i>	<i>Modest Innovators (4)</i>
Knowledge transfer	75 %	80 %	66.7 %	100 %
International S&T cooperation	100 %	40 %	80 %	75 %
European Labour Market	75 %	50 %	33.33 %	50 %
Modernising HEIs/PROs	75 %	70 %	60 %	100 %
Opening up & coordination	25 %	10 %	11.11%	50 %
World-class infrastructures	100 %	40 %	66.7 %	100 %

Source: Survey on ERAWATCH country experts, n=27, IPTS (2011)

Firstly, different country clusters show relatively large *consensus* on the most important dimensions, namely "Modernising HEIs and PROs" as well as "Knowledge transfer". However, consensus is limited in the dimensions of similar importance such as "International S&T cooperation" and "Building world-class infrastructure". In particular, innovation followers (2) consider the former as less important relative to all other clusters, while the latter is less important to both innovation followers and moderate innovators (country cluster 2 and 3). Notably, we observe a weak trend to rate higher across all dimensions in country clusters positioned at the back and front end in terms of their innovation performance (innovation leaders and modest innovators), whereas ratings document lower levels of importance for intermediate clusters (cc 2&3). Anyhow, this does not necessarily imply a lower general relevance of ERA to national policy due to the higher variance of responses and larger sample size in such clusters.

Figure 7. Heat map. Underperformance of national STI policies among country clusters (% rating "important" or "highly important" within cluster)

<i>ERA dimensions / country clusters</i>	<i>Innovation Leaders (1)</i>	<i>Innovation Followers (2)</i>	<i>Moderate Innovators (3)</i>	<i>Modest Innovators (4)</i>
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Towards a European Labour Market for Researchers , e.g. researcher mobility initiatives	50 %	30 %	77.8 %	100 %
Modernising research organisations, in particular universities, e.g. funding for universities	0 %	40 %	33.3 %	75 %
Opening up and co-ordination of national research programmes	75 %	40 %	66.7 %	50 %
Building world-class infrastructures	50 %	60 %	44.4 %	25 %
Knowledge transfer, e.g. funding for collaborative research	50 %	40 %	22.3 %	25 %
International Science & Technology cooperation, e.g. bilateral research schemes	0 %	30 %	11.1 %	25 %

Source: Survey on ERAWATCH country experts, n=27, IPTS (2011)

Secondly, most governments have underperformed in terms of policies related to "European Labour Markets" and "Opening-up and Coordination", as illustrated in above heat map. In particular, this seems to be the case among moderate and modest innovating countries (3&4). Similar holds for efforts in the dimension on "Modernising HEIs and PROs". In opposition, national policies on "Building world-class infrastructure" are relatively more underperforming among innovation leaders and followers (1&2). Good practice in current national policies is likely to be observed across all clusters in the domain of "International S&T cooperation". Lastly, we turn to experts' views on the potential target for future STI policy adjustments on ERA, in particular calls for EU level intervention.

Figure 8. Heat map. Adequate governance level among country clusters - (% proposing EU governance level within cluster)

<i>ERA dimensions / country clusters</i>	<i>Innovation Leaders (1)</i>	<i>Innovation Followers (2)</i>	<i>Moderate Innovators (3)</i>	<i>Modest Innovators (4)</i>
Towards a European Labour Market for Researchers , e.g. researcher mobility initiatives	100 %	55.6 %	66.7 %	100 %
Modernising research organisations, in particular universities, e.g. funding for universities	0 %	0 %	0 %	25 %
Opening up and co-ordination of national research programmes	33.3 %	11.1 %	22.2%	50 %

Building world-class infrastructures	100 %	66.7 %	33.3%	75 %
Knowledge transfer, e.g. funding for collaborative research	66.7 %	0 %	0 %	50 %
International Science & Technology cooperation, e.g. bilateral research schemes	33.3 %	66.7 %	55.6 %	75 %

Source: Survey on ERAWATCH country experts, n=27, IPTS (2011)

National experts call for exclusive action on EU levels, in particular on "European Labour Markets". Given a broad consensus among all cluster countries, this is being driven predominantly by innovation leaders and modest innovators. In contrast, there is divergence on the adequate governance level among almost all clusters in the domain of "Building world-class infrastructure" ("International S&T cooperation"), anyhow, EU involvement is relatively more (or less) favoured, if any. As highlighted above, interventions should mostly stem from national domains within "Opening-up and Coordination" and "Knowledge Transfer" dimensions. However, if any EU involvement is desirable within these dimensions, it is network experts among either innovation leaders or modest innovators who seem to call for this.

Taking into account *country cluster-specific assessments* on relative importance, focus of national policies and the degree of consensus among the latter, we are able to further specify and re-rank relevant policy dimensions. So again, on *EU levels*, regulatory efforts may want to focus on (1) "European Labour Markets", and (2) "Building world-class infrastructure".

However, national commitment to the second priority may suffer from limited consensus on its importance. On *national levels*, policies ideally should be focused on (1) "Modernising HEIs and PROs", in particular, increased efforts seem to be the policy option at national level for modest and moderate innovating countries. In addition, a favourable, national focus on (2) "Opening-up and Coordination" may hinder policy underperformance across all clusters, but especially for those countries affected by brain drain phenomena.

RELATIVE IMPORTANCE OF ERA DIMENSIONS IN MEMBER STATES POLICIES

In this section we summarize "anecdotal" evidence on potential ERA influence on national policy trends in recent years. We do so by revisiting and reviewing each ERA dimension, and highlighting the main trends within country clusters. Anyhow, as already highlighted in the description of the methodological approach of this report, such evidence is relatively scarce

and can only be randomly extracted from cross-reading³⁸ ERAWATCH country reports and information collected when surveying country experts. In this way, the evidence on impacts may lack some robustness which calls for cautious deductions, if any, from these results, with regard to future developments and interactions on national and EU levels.

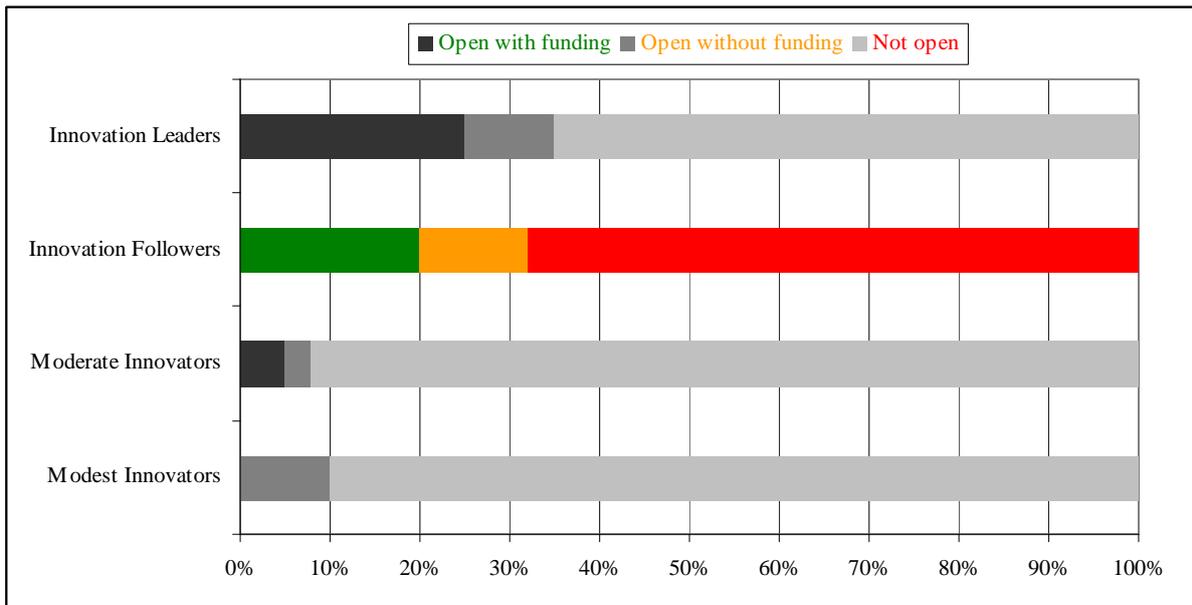
Towards a European Labour Market for Researchers. In most innovation followers countries, brain gain measures are combined with countervailing measures on brain drain in a coherent framework, generally not explicitly differentiating between attraction of EU and non-EU nationalities. The latter themselves are frequently part of overarching European programmes such as ERC and Marie Curie and, hence, heavily rely on contributions from EU funds. Alternatively, such schemes can be of bilateral and multilateral nature, e.g., with respect to scholarship contribution or organizational design of joint research programmes between MS. Similarly, policy efforts, if existing, on attraction and preservation of scientific talent in the national domains are largely based on investments from EU structural funds among moderate innovators. EU level funding processes on competitive research grants may initiate additional national funding. An interesting, good practice in this respect is Italy's policy on grants issued for those national early-stage researchers that are selected but do not actually win ERC grants.

Modernising research organization, in particular universities. As documented in many country clusters assuring high quality and excellence of HEIs and PROs is a major concern of public policy in all MS. However, countries and country clusters are at very different stages of reform or elaboration and implementation of evaluation practices. One potential way to overcome this divergence is active cooperation (in addition to the commonly information exchange on practices) among MS. E.g., the activities of the Austrian Agency for Quality Assurance being an advanced institution in this functional respect can be seen as a best-practice case for Europe as it does not solely assess and evaluate HEI performance but also advises institutions in other MS on further strategic development and general advancement (currently, some German HEIs undergoing the agency's inspection).

Opening up and co-ordination of national research programmes. Bi- or multilateral agreements on research programmes within ERA are frequently (seldom) run under a single framework programme and/or a single national public agency among "innovation follower" ("moderate innovator") countries, in particular those following a top-down STI approach. If a coherent national approach to bilateral agreements is under revision or only emerging in these respective cluster countries, national policy-makers seem to consider leveraging their efforts by enhanced activities in ERA-NETs as well as joint programming schemes on EU levels (e.g., Ireland and Austria). Often existing bilateral ties and formal agreements made operational in these countries are regarded as a means to improve national performance in EU schemes such as FPs.

1. **Figure 9.** *Openness of national R&I programmes by country clusters.*

³⁸ Guidelines for 2010 ERAWATCH country reports do not ask country correspondents to make explicit ERA impact on national policies, nor do they explicitly request information on drivers of policy trends and adjustments but rather document the latter.



Source: European Inventory of Research and Innovation Policy Measures Data: de Dominicis and Henriques (2011)

Building a world-class infrastructure. In a few countries among innovation followers, RI maintenance is secured by EU's structural funds additional to (initial) national public funding efforts which itself frequently leads to a multitude of national funding stakeholders, including business sector. In this way, some country experts suggest that, to some extent, it becomes increasingly difficult to clearly separate overlapping national from joint or inter-governmental research infrastructure with respect to access and longer-term maintenance, as, in particular, national RI strategies are getting aligned with international ones in most of the cases. In similar, in many countries among moderate innovators, RIs maintenance involve large shares of EU structural funds or "intentionally" overlap with international ones in order to benefit from other forms of EU co-finance. In both clusters, involvement in the European Strategic Forum on Research Infrastructure (ESFRI) has triggered writing RI strategies and related coordination as well as consultation efforts on national levels.

Knowledge transfer. The set of policy instruments tackling the issue has been amplified in many clusters, e.g., "classic" instruments such as KTOs or technology parks have been expanded recently to SME-focused innovation vouchers, measures fostering student or young researcher mobility, close-to-market product development grants and academic spin-off policies. Some of these policy developments and adjustments among moderate innovators (very seldom also among innovation followers) have been fine-tuned with EU initiatives, most likely due to either funding requirements or rent-seeking behaviour among MS.

International Science and Technology cooperation. Evidence on inward and outward mobility schemes addressing third country cooperation is relatively scarce among moderate innovators. However, if any favourable national regulation is in place it is often initially launched on EU levels. This includes regulation such as favourable work permit requirements, tax and social

security benefits for highly-skilled foreign workers. Most often it does not focus exclusively on scientists and requirements as well as benefits differ strongly for applicants from EU MS or third country origin. In general terms, in a few countries within the cluster, efforts on S&T cooperation have been launched on institutional, academic levels of HEIs, PROs or individual researcher level, rather than on national level. Unfortunately, country reports do not document the impact of ERA on institutional level.

In terms of a *taxonomy* of potential impacts on national policies, the dominant channel of transmission remains as one would expect the financial one. This "hard" factor of persuasion is particularly relevant for current policy rationales related to the following ERA dimensions: (1) *Towards a European Labour Market for Researchers*; (2) *Building a world-class infrastructure*; to a lower extent also in (3) *Knowledge transfer*. This factor seems to be most relevant in (2) as financial terms are likely the most important strategic concerns (more than content-related ones), in particular when it comes to establishment of future RIs and national involvement.

Anyhow, there are also an interesting, large number of "soft" drivers for national policy change in the ERA context, including for example: (1) *internationalisation* or temporary transfer of best-practice national public services/agencies among MS, i.e. active cooperation on quality assuring mechanisms related to the science base (see above Austrian-German example); (2) "*funding breeds funding*" effects deploying information and knowledge nationally that was created in excellent EU level competitive funding processes (see above Italian example); (3) *triggering* national strategy formulation and *leveraging* national funding efforts by enhanced activities in well-functioning EU level cooperation schemes, e.g., ERANETs as well as joint programming in the context of Opening up and co-ordination of national research programmes; (4) *creation* of bi- and multilateral R&D ties and formal agreements made operational among ERA countries are considered a *precondition* for higher national success rates in prospective EU funding activities; and lastly, (5) Involvement in EU level strategic forums may *incentivize* strategy development and consolidation of otherwise fragmented efforts on national levels, this being even more likely when intertwined with financial incentives. To sum up, next to the latter incentives, we find some supporting evidence on soft factors in most of the ERA dimensions.

EU/ERA POLICY IMPLICATIONS

Specific ERA dimensions are seemingly more important than others from national perspectives of MS, as confirmed by, both, ERAWATCH country experts as well as anecdotal evidence on impacts derived from above ERA analysis. Namely, these are

- (1) *European Labour Markets*, and
- (2) *Building world-class infrastructure*.

However, it is worth noting that these dimensions also largely lend themselves to financial incentives on EU levels and have already a certain history of financial support, in particular the one on infrastructures, i.e. this likely leading into path-dependency and overweighting/importance of specific ERA dimensions.

The second major finding is that ERA progress and integration takes place at variable speeds³⁹, both, comparing country clusters and between other specific sets of MS. In this way, given national and European budgets are tightening in the ongoing economic crisis, it may be also important to reconsider all the "soft" impact mechanisms as detected and highlighted by a number of policy best practices across Europe in the third chapter of this brief. Notwithstanding these impacts are documented in one or the other way across all ERA dimensions, this seems a particularly relevant issue for the (primarily national driven) policy domains of

(3) *Modernising HEIs and PROs*, and

(4) *Opening-up and Coordination*.

As discussed in the above chapters, *bi- or multilateral* agreements and more elaborated, active (e.g., institutional) cooperation and exchange play an important role in the context of these impact mechanisms, whereby EU level activities such as ERA-nets and similar EU constructs can serve as a learning environment and a test-bed for coordination in a variable-geometry style, largely appreciated by many MS. However, bi- or multilateral ties can also be an (exclusive) precondition for EU funding which may increase the significant, current MS divergence on ERA integration observed within and across country clusters. Hence, this calls for additional attention at EU level in order to uncover potentials for EU-wide harmonization of national policy practices and to preserve a certain degree of coherence in innovation performance among ERA members, i.e. ideally putting most countries on an economic growth track with similar prospects. A viable, first step⁴⁰ towards this would be an enhanced collection of data on *any* bi- or multilateral activities among MS within ERA with science and innovation relevance that would allow to a better understanding of present and future ERA geometry and hinder further MS divergence in terms of ERA integration in the long run.

Thirdly, we find the dimension on *Knowledge transfer* to be a likely area of potential policy failure, both, on EU and national levels, also drawing on the evidence discussed in complementary IPTS work⁴¹. More specifically, countries in clusters with relatively lower innovation performance may be most prone to tap further into these policy fields as rent-seeking EU funds; this, in turn, likely leading MS to increased systemic failure due to limited

³⁹ We hereby confirm key insights highlighted in the Innovation Union Scoreboard (2010) as well as echo some of the on-going discussion in the literature on the bottom-up or top-down nature of ERA and its evolution (Svanfeldt, Christian (2009), *An ERA built by the MS? In: European science and technology policy: towards integration or fragmentation?*, Delanghe/Muldur/Soete (eds.)).

⁴⁰ Consultation on next generation ERAWATCH country reports and related guidelines development should ideally take this into account.

⁴¹ IPTS (2011) ' *Research and Innovation Challenges and Policy Responses in Member States* ', by Mariana Chioncel and Alexander Cuntz

absorptive capacities of their businesses and still developing science base. In this particular case, it may document an adverse ERA impact/outcome.

A last, but not necessarily new finding which we like to stress is the important role of informational exchange from EU to national policy levels as well as between MS on EU level policy platforms, e.g., assessment results from EU level competitive funding processes feeding into national funding allocation efforts or impact on national policies from strategic consolidation, respectively.

ANNEXES

ANNEX 1. An example on synthesis methodology: ex ante stocktaking of country specific challenges and information on "Towards a European Labour Market for Researchers"

An example on synthesis methodology: *ex ante* stocktaking of country specific challenges and information collection on "Towards a European Labour Market for Researchers" Denmark, Finland, Germany, Sweden

Main Challenges Confronting National R&I Systems

Denmark

- There is still a significant need to improve the research infrastructure;
- The list of prioritised R&D areas are still very diverse and difficult to accomplish;
- Establishing a risk capital fund remains a vital step for helping new start-ups.
- The main barriers for private R&D investments are capital shortages and increased unemployment (from 3.3% in 2008 to 6.0% in 2009), both consequences of the financial crisis;

Finland

- Many new instruments have been introduced during the past decade by a various public actors, causing the system to become too complex to access and administer;
- There is no clear focus on thematic priorities;

- Better coordination between various instruments that promote business R&D investment is still needed;
- University reform may have negative impact on research funding in the short term;
- Large number of non-innovative firms;
- Research programmes may be too academic and policy programmes are too fragmented to be able to address societal problems.

Germany

- Private R&D demand continues to be dominated by (world-leading) medium-high tech manufacturing while the share of high-tech manufacturing in BERD is much lower than the EU average, and is also rather stable. As such, shortage of equity capital for companies and lack of highly qualified personnel may hinder structural change.
- Even though perceived as a valuable policy instrument of R&D funding, there are currently no R&D tax incentives complementing Germany's large portfolio of instruments.
- Institutional funding of universities is stagnating. As a matter of fact the focus on scientific excellence is limited to a small number of HEIs.
- Demand-side innovation policies such as public innovation-oriented procurement are underdeveloped.
- Governance on education policy requires complex policy coordination owing to split competences among federal states, limiting to some extent policy coherence and efficiency on national level. For example, there is no national road map setting research infrastructure priorities and autonomy of PROs and HEIs is still limited.
- In terms of human resources for scientific production, even though Germany is among the top-performing MS, education careers are separated fairly early, there is a relatively low percentage of students and graduates, and a low percentage of foreign researchers active in this country.
- Crisis-related stability policy and public deficit cuts put pressure on research, innovation and education policy budgets, so far being exempted from cuts on national level, but not on all federal levels. Please note that a fast economic recovery and continuous business R&D investment during times of crisis may eliminate the specific challenge in the middle-term

Sweden

- There is no formal and obligatory arena for coordination between the research and innovation policies;
- The 'Swedish Paradox' concept is still relevant: inadequate return on public investments in R&D (high inputs and low output = low productivity);
- Some evaluations point to imbalances in the Swedish system, such as the focus on 'knowledge creation' rather than 'value creation';

- Sweden's economic growth and resilience to the financial crisis will most likely have a positive effect on further public investments in research. Yet, the nominal BERD decreased during the crisis;
- Most R&D has been performed by large companies (MNC) and to a lesser extent by SMEs. The crisis is more likely to negatively affect R&D investment from SMEs, which will further impair the level of research activities. On the other hand, increasing globalisation and competition promoted MNCs to reallocate their R&D investments abroad;
- The entrepreneurial climate in Sweden remains relatively poor in comparison with many other European countries: Sweden ranks in the lower half of the Global Entrepreneurship index;
- There is lack of venture capital of in the earlier stages of the innovation process.

TOWARDS A EUROPEAN LABOUR MARKET FOR RESEARCHERS

DENMARK

- **Stocks and mobility flows of researchers**

The HRST, amongst the economically active population aged 25–64, was 51.8% in 2009 compared to an average of 40.1% for the EU27 (Eurostat, 2010). The HRST share amongst those aged 25-64, who are educated in science, mathematics and computing is only 5.4%, compared to the 10% EU27 average. The lower share of S&T graduates is consistent with concerns about a lack of engineers expressed by the private sector. This problem has been addressed and the numbers of PhD candidates in engineering has doubled since 2005. Statistics on the aggregate level indicate that Danish industry has a high absorption capacity, as companies invest heavily in R&D. The reasons for the unbalanced supply- demand seems to include the high shares of students in humanities and social sciences and the generous student grants available that trigger the late entry into the labour market.

Danish researchers are less internationally mobile than researchers in the EU.⁴² A share of 44% Danish researchers in the HE sector has been internationally mobile⁴³ compared to 56% EU average. However, Denmark shows an increasing inflow of foreign researchers and PhD candidates. Of the foreign PhD candidates that came to Denmark in 2007-2008, 53% came from ERA countries and 28% from Asia. The NRP 2008 highlights the internationalisation of education programmes: €12.1m were allocated for 2007–2009 for funding Danish students to go abroad and highly-qualified foreign students and teachers to come to Denmark

⁴² MORE project, specifically the "Study on mobility patterns and career paths of EU researchers".

⁴³ Researchers that have worked in a country other than the one where they attained their highest educational degree

- *Attractive employment and working conditions*

Denmark is a country with a flexible, mobile labour force, having a long tradition of long life training policies and funding schemes. Approximately €33m have been allocated in the period 2008–2011 to measures aimed to enhance skills of employees in the public service sector.

Providing attractive employment and working conditions are priority areas in Denmark, since the employment system for public researchers generally displays a high levels of flexibility. When considering the cost of living, the level of remuneration for researchers in Denmark is high. The comparison of the remuneration level for the different levels of education in the public and the private business sector also reveals a huge difference between these sectors. The remuneration gap between men and women in Denmark is small compared to other countries (below 5% after 15 years of working life). However, there is evidence of a considerable loss of female research talent. Although more women than men graduate from Danish universities, only 28% of all senior lecturers, and 14% of all professors, are women. Several measures for achieving a balance between working life and family life have been introduced such as flexibility schemes and the possibility work part-time, access to a “global workplace”, encouragement to go on maternity/paternity leave, and at the end of the leave the opportunity to return to a research term without any teaching obligations.

Open recruitment and portability of grants

The Ministerial order on the Appointment of Academic Staff at universities stipulates that ‘positions at professor and associate professor levels have to be posted internationally’, while this is not mandatory for lower level positions. However, generally the research job vacancies are internationally advertised (on the EURES, the EURAXESS or other job portals).

The “Scientific Visa” package has not been implemented in Denmark. Instead, other schemes have been used to facilitate work entry and provide favourable tax conditions for foreign researchers. The agency for the recognition of professional qualifications has the responsibility to assess the professional qualifications of emigrants entering Denmark. In this system, a PhD qualification gives a high score, which is necessary for getting a ‘green-card’ for access to Denmark. Denmark is part of the European system that coordinates national social security rules. Payments are also made to national pension funds in addition to salaries for all foreign researchers employed in Denmark.

The Danish Councils of Independent Research participate in the EUROHORCS initiative, authorizing researchers moving to other countries to take the remainder of any ongoing grant with them, while the Council for Strategic Research, while the DCSR has not signed the letter of intent ‘Money follows researchers’.

Finland

Stocks and mobility flows of researchers

In 2009, in Finland the HRST share of the economically active population in the age group 25-64 was 50.7%, higher than the EU27 average (40.1%) (Eurostat, 2010). In 2008, the share

of researchers in the labour force was 1.62%, more than double than the EU27 average of 0.68%. The share of researchers working in the private sector was 59%, compared with 45% in the EU27 (2007). In the period 2000-2009, the total amount of doctoral degrees increased from 1,156 to 1,642 (42%), while the number of doctoral degrees in S&E has increased in the same period with 65%. The HE system is well developed, covering one third of the age population. Opportunities for on-the-job learning as well as life-long-learning are good, having several financial instruments attached.

While the relative share of people with tertiary education has been relatively stable over years, the absolute numbers have dropped, due to the demographic decrease. Therefore, in Finland the need to ensure a sufficient number of qualified human resources is considered one of the key challenges. One way to deal with this human resources shortage is to attract foreign researchers in order to maintain the high level of R&D and innovation activity. However, in international comparison the inwards mobility of foreign professionals has been relatively low. Also the outflow of researchers and PhD students (except the technical fields) has declined since the beginning of 2000s.⁴⁴ The barriers between public-private sectors are generally low and it is not rare, particularly in the engineering sector to move from academia to industry.

Providing attractive employment and working conditions

In 2006, the gross salary level (PPS) of researchers in the HE sector was 33,084, while in PROs 37,173. When looking at salaries based on experience, young researchers (0-4 years of experience, all sectors, PPS) have an average salary of 22,825, which is above the EU25 average (20,374). Experienced researchers (over 15 years of experience) the average salary was 48,992, below the EU average (55,213). Compared with the GDP and general annual earning it can be noted that researchers' salaries are not very competitive. The recent university reform (2010) gave universities more autonomy to determine salary levels. The basic salary level is negotiated as part of the collective agreement, while individual salaries are determined by assessment of the job description which adds to the basic salary. This provides some flexibility in the salaries.

The Academy of Finland and the Finnish Council of University Rectors (representing all universities) have signed the Charter for Researchers. Therefore all the regulations regarding transparent recruitment and promotion careers are implemented. However, the competition for permanent academic positions is high and most of the researchers work is funded on project base. Overall Finnish labor researchers market is not very attractive: the long term career opportunities are limited given the low number of permanent positions and the remuneration levels are lower than in many other European countries.

There are not specific regulations that may hinder the career progression of female researchers. The project funding typically allows researchers to take maternal leave and to

⁴⁴ The outflow of domestic teachers and researchers (long visits over 1 month) was 699 (741 in 2000). The inflow of foreign researchers and teachers to Finnish universities was 1,172 people (1,153 in 2000) in 2009. (Source: KOTA-database, 2010).

receive an extension of the contract after the maternity leave. In practice this is seen as slower career development: a majority of professors are men even though almost half (46% in 2007) of researchers in the HEIs are female. The small number of females in the university management has also drawn the attention of the Ombudsman for Equality in Finland and in 2011 the gender equality in universities is under specific monitoring. The Act on Equality regulates that all the organisations with more than 30 employees to have an equality plan and promote equal rights and opportunities.

There are tax incentives for participating in voluntary supplementary pension schemes. Researchers' contracts are subject to social and health taxes if they are paid salaries. Individual grants are exempt from taxes.

Open recruitment and portability of grants

The academic positions are typically open: non-nationals are eligible to apply for permanent research positions. In practice some extra commitment is still required. For example the Academy of Finland research posts are open for foreign applicants but in this case the host university must agree to provide the research infrastructure for the applicant. The salaries in the university sector are not very competitive, although top senior researchers may be given a higher salary. An additional limitation for the foreign researchers is the difficulties faced by the partners in getting a job (at least partly due to language issues). Nevertheless, the number of professors and researchers coming from abroad has increased lately

One positive feature in Finland is that foreign researchers are not expected to be fluent in Finnish as English is widely spoken. This offers more opportunities for foreign mobile researchers to find work opportunities. In teaching this situation is often different as the permanent teaching staff (including Professors) is expected to be able to speak Finnish (and Swedish).

There is not any specific system in place for recognizing professional qualifications of foreign academic degrees and hence support international applications. These are typically assessed case by case.

Grants from Academy of Finland and Tekes are not typically portable. Grants may support temporary visits in a foreign institution but typically most of the work is expected to be carried out in the host institution. Basically there are rules and practices to help foreign researchers to work in Finland but the information is fragmented and there has not been any dedicated instruments to facilitate the immigration of foreign experts (except some short term tax deductions). The private sector has also not been very keen to recruit foreign researchers except for the few international companies. The administrative limitations at the universities have also made it more difficult to compete internationally (e.g. salaries). The administrative reform at the universities starting from 2010 may help to address these issues.

Finland has implemented all the relevant directives regarding cross-border provision of financial and insurance services. There is not any specific scientific visa system in Finland. All EU and EEA researchers are free to move to Finland. Researchers from other countries

need a regular work permit if they stay in Finland for more than 3 months. However, scientists are also able to get a specific work permit for a maximum of 1 year when they have an invitation from the host institution. Highly educated scientific workforce is also exempt from the regular needs assessment that normal work permit applications are subject to.

GERMANY

Stocks and mobility flows of researchers

Germany is particularly strong in the training of young scientists and scholars. 24,000 people successfully completed a doctorate in 2005, which amounts to about a quarter of the new doctorate holders in the EU-27. The labour market perspectives in Germany rise substantially with increasing levels of education. In 2009, the unemployment rate of people having tertiary level education (ISCED level 5 and 6) was only 3.3%, compared to 10.8% for people having an education of ISCED level 3-4 and even 19.8% for ISCED level 0-2.

In terms of ability to attract foreign doctoral students, Germany with a share of about 12% of doctoral degrees taken by foreigners in 2005, underperforms when compared to UK (40%). On the other side, Germany has the highest share among the foreign doctoral students in USA. The researchers inflow exceeds the outflow, Germany achieving the greatest “migration gain” from Russia, China, India and Poland. However, the number of nationals working abroad is very high also, and lately concerns about brain drain, in particular to the US, have been grown. In response to this concern, a specific scheme GAIN was established (in 2003) to support German scientists working in the USA to return to Germany.

In order to enhance international mobility of researchers several programmes have been implemented, in particular by the German Academic Exchange Service (DAAD), the German Research Foundation (DFG), the Max Planck Society, the Alexander von Humboldt Foundation (AvH) and for USA the Fulbright Commission. To attract foreign, world-leading international researchers, in 2007 a new international grant for research in Germany (Alexander von Humboldt Professorship) was established by the Alexander von Humboldt Foundation. It endowed with up to €5m.

Providing attractive employment and working conditions

While Germany is attractive in terms of education and access to RIs, the integration of young PhD holders into the labour market and their overall perspectives still need to be improved. The academic career path is very difficult since it follows a very rigid pattern. Short term contracts are the norm, and permanent positions as independent researcher are rarely available. In order to avoid the brain drain, especially to the US, measures like a career track for post-docs (Junior Professor) have been established. However the implementation has fallen short of expectations and since the maximum duration of a series of temporary contracts was limited to 12 years, there was still a big uncertainty for this group of

researchers. In April 2007 a new law on temporary contracts in science has entered into force, which overcomes the 12-year limit for temporary work contracts. So far, only one fifth of the university teachers receive permanent positions.

In 2006, the average total annual salary of a researcher in Germany, taking into account the cost of living is €3,358, exceeding the average EU-25 salary (€40,126). However, these salaries in comparison to those paid by private enterprises are still low. Moreover the rather rigid remuneration system in the public sector is considered inadequate for attracting excellent researchers. In the reform of the salaries of professors (2002) for the first time limited performance components were introduced that go beyond the stipulations of the “Tarifrecht” (public salaries regulation).

Although increasing, the percentage of female researchers in Germany (12% in 2007) is still low compared to EU27 average (19%). The share of women holding professorship positions increased from 7.5% to 16.2% between 1992 and 2007. Recent studies criticise the difficulties young researchers have to face when becoming parents which are seen as key reasons for both a high percentage of childless researchers and women not realising their careers as researchers. Obstacles are for example the short term contracts, challenging amounts of working hours, required mobility, difficulties of “dual careers” and traditional social norms. The federal government and states are therefore implanting initiatives to improve the situation of women and parents in the research environment. In general, both men and women can take advantage of the “*Elternzeit*”, the possibility to leave the work for up to 3 years (this can be split between the parents) with a guarantee of work afterwards. In 2007, a new parental allowance programme (“*Elterngeld*”) was introduced. “*Elterngeld*” is a reimbursement that is paid up to 14 months to support financially the parent not working and consists of 67% of the yearly average net income before birth, with a minimum payment of €300 and a maximum payment of €1,800 per month. The programme also addresses highly qualified persons with a high income, who were not eligible to benefits under the former legislation. There is also a lack of affordable and good quality child care, particularly for children under the age of three; however, measures are taken to expand the offer. The federal government will be ploughing €4b into the expansion of childcare facilities by 2013.

Specific measures to support female researchers were taken: the national reform programme 2008-2010 (*Bundesregierung, 2008*) addresses among others the issues of women professors: around 200 professorships for women are being jointly funded by the federal government and the states through start-up financing. Another measure is the national pact between partners from industry and the state, aiming to develop the potential of women in the field of natural sciences and technology by allocating scholarships.

Open recruitment and portability of grants

The share of foreign professors is ~5.6% of all professors employed by German HEIs. The majority of them are scientists from Europe, plus a sizeable share of Asian researchers. The most recent public higher education laws demand that vacancies are advertised internationally and only allow exceptions in special cases. Scholarships are increasingly being advertised

internationally, resulting in an increasing number of applications from abroad. Also on the positive side, the Lisbon convention on the recognition of qualifications has been ratified by Germany. In November 2010, the Federal Ministry of Education and Research introduced a bill to further develop a uniform and transparent assessment and validation of qualifications acquired abroad in order to use the potential of skilled foreigners already being in Germany. Barriers to the recruitment of international staff include a high insecurity concerning career paths, a relatively small number of long term contracts, and lower salaries compared to the US and Switzerland.

In the National Reform Programme 2008-2010 (*Bundesregierung, 2008*) there are measures of the federal states aiming to enable the mobility of researchers, amongst others by enabling foreign nationals to be appointed as civil servant. However, no further information on the implementation status was provided. In early 2005, the Immigration Act came into force, which is supplemented by the implementation of the EU Third-Country Researcher Directive that facilitates the residence permit process for research institutes hiring researchers from third countries. Also with the implementation of the programme “*Labour Migration helping to ensure the adequate supply of skilled workers in Germany*” (July 2008) the barriers to the immigration of highly-qualified and highly-skilled professionals were removed. The academic labor market will be opened, although there will still be carried out the priority check (“*Vorrangprüfung*”), which makes sure that no German researcher would be suited for the post (BMI, 2008). In 2009, the income threshold for obtaining an unlimited settlement permit was reduced from the €6,400 to €4,800 for highly qualified foreign workers. To increase the number of international researchers at German universities, the Alexander von Humboldt Professorship and other measures from the Alexander von Humboldt Foundation started. These are for example programmes for postdoctoral researchers, junior research group leaders, experienced researchers and internationally recognised professors (Humboldt Foundation, 2009). Grant holders, research assistants and research associates working at scientific-research institutes funded exclusively or mainly from public funds do not usually need a work permit. There is also a special “residence permit for researcher” which is a combined residence and work permit and also allows the researcher’s spouse to work in Germany. Holders of grants or scholarships are usually exempt from paying social contribution and taxes. European researchers are usually part of the German pension scheme and there are Social Security Agreements (“*Sozialversicherungsabkommen*”) with a number of countries. There are several different schemes for private supplementary pension schemes with different tax incentives to make participation more attractive (for more detailed information see EURAXESS website). Germany takes part in the “[Scientific Visa Package](#)” which has been implemented to facilitate the procedures of admitting researchers coming from non-European countries.

Many research funding organisations such as the German Research Foundation (DFG) offer schemes which enable the portability of grants to a certain extent. Alternatively scholarships are provided for shorter or longer stays abroad, for instance by the Alexander von Humboldt Foundation and the Max-Planck-Society.

Sweden

Stocks and mobility flows of researchers

The share of researchers in Sweden made up 0.98% of the total active population in 2008. This is a decrease from earlier years when the same number was over 1%. The business sector has the highest share, employing 0.68% of the total active population. The HE sector is the second most important sector with 0.26% representing a total of 25,000 persons, excluding PhD students. In October 2009 25,000 full time equivalents were hired as academics and researchers in Swedish HEIs, an increase with 4% in a year. More than one third (35%) of the teaching and research personnel have short time contracts and 34% of them are 55 years or older.

The number of enrolled PhD students has in the last years been relatively stable over the years (3,400) and the proportion of foreign doctoral students has increased from 19 to 31% in the period 2000 and 2009. The areas of medicine and engineering sciences accounted for more than half of the newly enrolled PhDs. The Swedish universities have an international reputation for providing high quality education and in recent years the number of foreign students applying to universities has increased substantially. The most common and secure way of funding postgraduate studies is through PhD studentships which cover also social benefits and are regulated by same rules for national and foreign applicants. Approximately 50% of doctoral students have such PhD fellowships. In recent years, there have been concerns regarding the low number of engineers and students studying natural sciences. In 2009 almost 1,100 PhD students participated in international mobility schemes involving periods longer than three months. This is the highest number of outward mobility since 1999, when the first data were collected. Regarding senior researchers, the outward mobility was 670 individuals in 2009, the academic staff accounting for one third of the total. Inward mobility was around 800 foreign researchers in 2009.

The majority of both private and public foundations and agencies have programmes funding outward mobility at different research career stages. VINNOVA has also introduced measurements that facilitate and encourage mobility between different sectors.

Providing attractive employment and working conditions

Swedish researchers are located in the middle band of EU15 countries, when comparing average yearly salaries in Europe. Researchers working in the HE sector have higher salaries than in other sectors. Researchers' salaries should theoretically be individually determined but are often decided centrally on faculty or research-council level. Researchers in similar positions do often have the same salaries. Most universities and university colleges are in some form of financial difficulty due to reduced funding per student, reduced base funding for R&D, and increased costs. This has resulted in universities employing researchers that are able to attract external funding. Initiatives stimulating the inward mobility of foreign researchers such as tax reductions are in place. Such tax incentives include the provision that foreign (EU and non-EU) experts, executives, scientists, researchers only pay tax on 75% of their income during the first three years in Sweden. Overall, both mobility between sectors

and international mobility have gained increasing importance for career development in the last decade. This has further been highlighted in the research bills.

The national pension system is made up of two contributions: the Income Pension which comprises 18.5% of the salary and is paid monthly by the employer into the national pensions account and the Premium Pension (2.5%) to be invested into a fund of choice. All researchers that have a salary or a residence permit for a year or more have access to social and health insurance on the same terms as Swedish citizens. This implies that medical care is subsidised and that the individual is eligible for state-sponsored compensation in case of sickness for a prolonged period. If the stay is limited to one year but the salary is provided by a Swedish employer, individuals might still be eligible for a certificate that entitles them to medical care. If researchers are on a scholarship and not paying tax, they will not be eligible for healthcare and other benefits.

The Association of Swedish Higher Education (SUHF), which organises the 42 Swedish universities and university colleges, signed “The European Charter for Researchers” and “The Code of Conduct for the Recruitment of Researchers” in 2007. Since then, most of the issues covered by these initiatives are fully implemented in Sweden.

Parental leave in Sweden is probably the most generous in Europe and has served as a model for many other countries. All working parents are entitled to 16 months of paid leave per child. To encourage greater involvement by both parents a minimum of 2 months is required to be used by the parent that takes the more limited involvement in childcare, usually the father. This has resulted in more fathers staying at home and employers being more tolerant towards parental leave. However, since the women usually stay home longer and take a greater responsibility for childcare, they face professional disadvantages compared to their male counterparts. Non-permanent contracts are normally extended by up to one year in case of maternity leave or for a time commensurate to how long the parent decides to stay home. This is partly due to the fact that it is the social security system paying the parental benefit and not the employer.

Even though Sweden has a reputation of being a country with high standards of gender equality, there are still major inequities between men and women. Only a small percentage of high-level academic posts are occupied by women. In order to achieve more gender equality in higher education, positive discrimination can be used when recruiting staff for graduate schools and other positions. A number of funding activities are aimed only at female researchers. The long-term objective is to increase the number of female doctoral students with the potential of becoming research leaders.

Open recruitment and portability of grants

Swedish universities and industry are publishing research related positions on the European Researcher’s Mobility Portal. These positions can either be covered by public funds or private funds depending on the organisation with the free position.

Since 2006 EU/EEA citizens do not need any work permit to stay in Sweden. If their stay is longer than three months researchers need to register with the Swedish Migration Board. Citizens of a Nordic country (Norway, Finland, Iceland, and Denmark) do not need a residence permit. As for third country citizens a new legislation came into force on first of July 2008, which is based on the EU's Researchers Visa Directive. According to these rules no work permit is needed, if the purpose is to teach or lecture during a period of time shorter than three months. If the purpose is to be hired as a researcher for any period of time a work permit is required before arrival. One of the main problems has so far been that the time foreign researchers can be affiliated with universities is limited to two years. According to a new legislation on improved conditions for foreign recruitment this might be changed to four years.

The Swedish National Agency for Higher Education is the public agency responsible for recognising qualifications from abroad. Sweden as a member state is following the directive 2005/36/EC that stipulates the terms for the mutual recognition of diplomas, certificates and other evidence of formal qualifications. The agency evaluates most foreign higher education programmes. The foreign education is compared to undergraduate and postgraduate programmes from other countries with those provided in Sweden. The comparison is expressed in terms of Swedish degree levels. The evaluation does not involve any award of a Swedish degree. All decisions regarding admissions and transfer of credits from prior learning abroad are made by the universities and higher educational institutions themselves.

In the case of getting a profession recognised in Sweden, the competent authority responsible for the profession makes the decision. There is a clear system how to get a profession recognised with a list of documents that have to be submitted with the application. After the application has been submitted the agency has three to four months to assess the application and notify the applicant. The authority may decide to admit the application directly, ask for further information about the professional experience, ask about undertaking compensation measure, or deny the admission to the profession. Sweden has few regulated professions in comparisons with other countries.

The Swedish Research Council (VR) is working towards making it easier for funded researchers to transfer the grants awarded to other countries in case of relocation. VR has therefore, on the initiative of the European Heads of Research Councils (EUROHORCs), signed the Money Follows Researcher (MFR) agreement. According to this agreement, a researcher moving to a country in which there is an organisation that has also signed the MFR agreement, can take along the remaining part of a grant. Project Research Grants and Research Equipment Grants (<SEK2m) are eligible.

ANNEX 2 The Origin of the Country Clusters: Extract from the Innovation Union Scoreboard

Innovation union scoreboard: Findings for Member States

Innovation Performance

A summary picture of innovation performance is provided by the Summary Innovation Index, a composite indicator obtained by an appropriate aggregation of the 24 IuS indicators (see Section 7.1 for a brief explanation of the calculation methodology and the IuS 2010 Methodology report for a more detailed explanation). Figure 3 shows the performance results for 27 EU Member States. Based on the Summary Innovation Index, the Member States fall into the following four country groups:

- Denmark, Finland, Germany and Sweden all show a performance well above that of the EU27. These countries are the Innovation leaders.
- Austria, Belgium, Cyprus, Estonia, France, Ireland, Luxembourg, Netherlands, Slovenia and the UK all show a performance close to that of the EU27. These countries are the Innovation followers.
- The performance of Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovakia and Spain is below that of the EU27. These countries are Moderate innovators.
- The performance of Bulgaria, Latvia, Lithuania and Romania is well below that of the EU27. These countries are Modest innovators.

Calculating composite scores

The overall innovation performance of each country has been summarized in a composite indicator (the Summary Innovation Index). The methodology used for calculating this composite innovation indicator will now be explained in detail.

step 1: Identifying and replacing outliers

Positive outliers are identified as those relative scores which are higher than the mean plus 2 times the standard deviation. Negative outliers are identified as those relative scores which are smaller than the mean minus 2 times the standard deviation. These outliers are replaced by the respective maximum and minimum values observed over all the years and all countries.

step 2: setting reference years

For each indicator a reference year is identified based on data availability for all countries (for all countries data availability is at least 75%). For most indicators this reference year will be lagging 1 or 2 years behind the year to which the IuS refers. Thus for the IuS 2010 the reference year will be 2008 or 2009 for most indicators.

step 3: Imputing for missing values

Reference year data are then used for “2010”, etc. If data for a year in-between is not available we substitute with the value for the previous. If data are not available at the beginning of the time series, we replace missing values with the latest available year. The following examples clarify this step and show how ‘missing’ data are imputed. If for none of the years data is available no data will be imputed.

step 4: determining maximum and minimum scores

The Maximum score is the highest relative score found for the whole time period within all countries excluding positive outliers. Similarly, the Minimum score is the lowest relative score found for the whole time period within all countries excluding negative outliers.

step 5: transforming data if data are highly skewed

Most of the indicators are fractional indicators with values between 0% and 100%. Some indicators are unbound indicators, where values are not limited to an upper threshold. These indicators can be highly volatile and can have skewed data distributions (where most countries show low performance levels and a few countries show exceptionally high performance levels). For the following indicators skewness is above 1 and data have been transformed using a square root transformation: Non-EU doctorate students, Venture capital, PCT patents in societal challenges and License and patent revenues from abroad.

step 6: Calculating re-scaled scores

Re-scaled scores of the relative scores for all years are calculated by first subtracting the Minimum score and then dividing by the difference between the Maximum and Minimum score. The maximum re-scaled score is thus equal to 1 and the minimum rescaled score is equal to 0. For positive and negative outliers and small countries where the value of the relative score is above the Maximum score or below the Minimum score, the re-scaled score is thus set equal to 1 respectively 0.

step 7: Calculating composite innovation indexes

For each year a composite Summary Innovation Index is calculated as the unweighted average of the re-scaled scores for all indicators.

ABBREVIATIONS

ESFRI - European Strategic Forum on Research Infrastructure

FP – Framework Programme

HE – Higher Education

HEI – Higher education Institution

KT – knowledge transfer

KTO – knowledge transfer offices

MNC - Multinational Companies

MS – Member States

PRO – Public Research Organisation

RI – Research Infrastructures

SF – Structural Funds

SME – Small Medium Enterprises

European Commission

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Abstract

The central aim of this report is to identify policy trends on national levels and across all six ERA dimensions, the latter as set out by in the 2007 ERA Green Paper. In particular, the report sheds light on those national policy developments driven by EU/ERA level activities, and on the relative importance of specific dimensions in the overall ERA framework from a national perspective. This work is based on two main sources of information: the 2010 ERAWATCH Analytical country reports and the responses to a questionnaire circulated among the ERAWATCH country experts. The report covers the 27 EU MS clustered in 4 four country groups according to their innovation performance.

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.



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