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Intersectoral mobility and knowledge transfer. Preliminary evidence of the impact of intersectoral mobility policy instruments

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Abstract

This report aims to map the policy measures supporting intersectoral mobility in the Member States and based on the policy measures evaluations analyse the available evidence of their impact. The analysis shows that policies to foster intersectoral mobility are in place in almost all MS. Many of them have been implemented for several years now, yet the readily available evaluations are scarce. The existing evaluations are also often coming short of evaluating the broader socio-economic impact. Yet, the evaluations provide evidence of positive impact of those measures on researchers' skills and employability. To a lesser extent data points to the impact on patents' and publications' propensity and R&D intensity of companies. The strongest evidence is provided in the industrial PhDs evaluations and the impact on skills and employability of PhD researchers can be clearly attested.

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Executive summary

Policy context

The paper analyses knowledge transfer through the prism of intersectoral mobility of researchers. That is the temporary or permanent mobility from one sector to another, mainly from the public to the private sector and back. It analyses the impact of policy measures in EU Member States by building on existing, readily available evaluations of different types of policy measures.

The importance of knowledge transfer policies for Europe's competitiveness has long been recognised by the European Commission and its Member States. The 2012 Communication on 'A Reinforced European Research Area Partnership for Excellence and Growth' lists optimal circulation, access to and transfer of scientific knowledge including via digital ERA among its five priorities. Commitment 21 of the Innovation Union points out the importance of collaborative research and knowledge transfer within the research Framework Programmes.

In the period 2011-2016, the European Semester process has delivered thirteen Country Specific Recommendations related to knowledge transfer. In 2015, the European Commission raised the issue of knowledge transfer and the necessity to strengthen the links between academia and business for fifteen Member States, which shows an increasing policy attention to that matter.

Key conclusions

Policies to foster intersectoral mobility are in place in almost all MS. Many of them have been implemented for several years now, yet readily available evaluations are scarce. In the small sample of the evaluations we have analysed, the evaluations provide evidence of the positive impact of those measures on researchers' skills and employability. Also, there are some evaluations which report some limited positive impact on patents' and publication propensity as well as the R&D intensity of companies.

The strongest evidence is provided in the evaluation of "industrial PhD programmes", where the impact on skills and employability of PhD researchers is clearly attested.

The analysis of policies supporting spin-offs provides evidence for increasing the entrepreneurial capacity of research organisations and promoting the translation of research results into economic value.

The policy measures also build industry awareness of knowledge transfer, increase the absorptive capacity of firms for internal and external R&D, strengthen academia – industry collaboration and build trust between actors.

The main barriers relate to the unclear benefits to participating firms, the high administrative burden on companies as well as the additional workload linked to integrating new people into the company. The need to understand the impact of the various types of programmes and the observed lack of high quality evaluations for existing programmes provide a strong argument for strengthening the evaluation capacity in member states and encouraging frequent and systematic assessments.

Main findings

The mapping of the intersectoral mobility policies per country shows that the most often implemented types of policy interventions are: 1) funding and regulatory support for Industrial PhDs and industrial traineeships; 2) post-doctoral researcher placements (Industrial Post-Docs and other similar measures) stimulating the uptake of PhDs by private sector firms/SMEs; and 3) support measures for creating spin-offs. One observes that most countries have implemented a broad range of policy instruments to promote intersectoral mobility. This holds both for countries with high and lower levels of business employment of researchers. EU-13 countries in general deployed the measures quite recently and on a pilot basis – which partially explains the lack of evaluations.

For the three types of measures a limited number of readily available evaluations were identified. In total, we have found 19 evaluations, covering 9 countries (8 EU Member States and Canada), of the three aforementioned types of measures.

In terms of the impact on career perspectives and employment the industrial PhD programmes are reported to represent "good value for money". Participating candidates acquire new skills, practical experience and improved qualifications, thus increasing their chances on the labour market but also representing highly qualified personnel which contribute to increasing the firms' "absorptive capacity". Several evaluations report a positive impact on a series of outputs, such as larger number of patents, increased exports and annual sales, bigger market shares and additional R&D funding from the industry.

The potential in relation to the level of mobility these measures create is significant: since the primary goal for this type of policy measures is to ensure an industry placement of PhD students while they pursue their doctoral studies at a university, intersectoral mobility represents a natural outcome of such schemes. Some evaluations also report longer term impacts on mobility. Moving back and forth between the public and private sector, the researchers create a network of contacts and serve themselves as intermediates between public and private entities. Well-designed PhD projects, previous knowledge of the partner organisation and the development of a research strategy by the firm are prerequisites for success of the policy measure.

As far as the uptake of post-doctoral researchers by industry is concerned, evidence shows that in all long term placements the recipients are directly employed by the company and only the research-related part is reimbursed by the programme. This creates a stronger relation with the company. Short placements may increase awareness among companies of knowledge and technology transfer activities and build trust between the actors. However, the evaluations do not point to significant tangible outputs such as increased patenting activities or co-publications. Longer post-doctoral placements create a personal relation with the company and often result in prolonged collaboration and/or in the offer of permanent employment in the host company. Programmes targeting specific groups (e.g. women, SSH researchers) are mostly pilots and too limited in scope to yield sufficient measurable impact.

The policy measures supporting spin-off creation have had an indirect impact on intersectoral mobility. By fostering a culture of entrepreneurship in university teaching, research and management; developing the potential for business ideas at universities and research institutions in a targeted manner; and promoting the translation of research findings into economic value; they have helped increasing the number of innovative business enterprises and created employment for public sector researchers in the private sector. In general the spin-offs supported through these programmes have remained small.

The main barriers include the lack of awareness by industrial firms, unclear expectations from the programmes on the side of businesses, the high administrative burden linked to application as well as additional costs for the hosting company (financial participation but also human resources devoted to mentoring).

The combination of different instruments could create synergies and this is an avenue worth exploring in order to achieve a systemic change.

Related and future JRC work

This report ties into forthcoming work by the JRC on Entrepreneurial universities, which will analyse the impact of national policies on the extent to which different types of universities succeed in building fruitful interactions with their innovation ecosystem.

1 Introduction

Knowledge transfer between research organisations and business enterprises plays an important role in innovation which makes understanding the mechanisms of these knowledge flows important to the design and application of adequate innovation policies. The strong performance of public research institutes and universities in Europe is not fully matched by the innovation performance of the economy.[1] Increased intersectoral collaboration can facilitate access to knowledge, its co-production by different actors through new research collaboration, and enhance its dissemination. It can also ensure industry-relevant teaching and create new employment oportunities by stimulating economic growth.

The importance of knowledge transfer policies for Europe's competitiveness has long been recognised by the European Commission and the EU Member States.[2]

The 2012 Communication on 'A Reinforced European Research Area Partnership for Excellence and Growth' lists optimal circulation, access to and transfer of scientific knowledge including via digital ERA among its five priorities. Commitment 21 of the Innovation Union pointed out the importance of collaborative research and knowledge transfer within the research Framework Programmes and beyond, as well as of intellectual property protection models and of knowledge transfer offices.

In the period 2011-2016, the European Semester process has delivered thirteen Country Specific Recommendations related to knowledge transfer. In 2015, the European Commission[3] raised the issue of knowledge transfer and the necessity to strengthen the links between academia and business for fifteen Member States, which shows an increasing policy attention to this issue.

This report is focused on intersectoral mobility (ISM) as a key mechanism for transferring knowledge. The document presents an overview of national policy measures supporting intersectoral mobility. Building on evaluations of selected measures, the report provides insights into the results that the different types of policy initiatives have achieved. It aims to take stock of the outcomes, outputs and socio-economic impacts of those schemes, such as increasing the absorptive capacity of private firms and increased employability of researchers in industry.

The report is structured as follows. Section 2 provides the conceptual framework of the analysis. Section 3 discusses the performance of the European Member States and selected third countries using selected indicators related to intersectoral mobility. Section 4 outlines the methodology applied in the study. Section 5 presents and analyses policy measures supporting intersectoral mobility. Based on evaluation reports, section 6 provides evidence of the impact of policies supporting intersectoral mobility. Finally, section 7 draws conclusions and presents the key policy messages stemming from the study.

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[1] For a critical discussion of this argument see Jonkers and Sachwald (forthcoming)

[2] 2007 Communication on Improving knowledge transfer between research institutions and industry across Europe, http://ec.europa.eu/invest-in-research/pdf/com2007182_en.pdf

[3] In the Country Reports (Commission Staff Working Documents) which are part of "The European Semester", the EU's annual cycle of economic policy guidance and surveillance.

2 Conceptual framework

Knowledge transfer encompasses all the functions that "may lead to improved use of knowledge developed and held in the research sector for the benefit of society and its individuals" (Finne et al. 2011). Early innovation policies were based on the conceptualisation of knowledge transfer as a linear process of public sector researchers producing new knowledge, which is then transferred to industry and subsequently used in innovative products, processes and services (Arnold et al., 2012; DeBackere et al, 2014). However, a broad body of theoretical and empirical literature suggests that the linear model does not offer an adequate explanation of the way in which knowledge flows and innovation occur in practice. Innovation is nowadays understood as a complex, interactive, non-linear and risky process, involving multiple feedback routes between research, development and innovation processes and the people involved in them both inside and outside specific firms (Faberber (2005), Rothwell (1994), Benoit (2005) in Arnold et al, 2012). The **open innovation** model has more recently conceptualised innovation as a more fluid process: authors like Chesborough (2003) argue that one can no longer strictly demarcate between actors performing distinct roles in innovation processes. Firms not only rely on both external as well as internal knowledge and expertise, but become co-creators of knowledge, which can be used by themselves or other firms and research organisations in their innovation ecosystem. In these systems that are characterised by more open boundaries between knowledge producers, public research organisations need to incorporate the needs of knowledge users in their activities and become co-creators of new solutions together with private actors. (Arnold et al, 2012; Finne et al., 2011)

Knowledge transfer between academia and business is a complex phenomenon, which takes place through a number of mechanisms like informal interactions among people, formal partnerships and exploitation of intellectual property. The present study is focused on the flow of research skills, which are inherently tacit: i.e. person bound. **Intersectoral mobility** is at the core of knowledge transfer between the academic and non-academic sectors. In its narrow sense, intersectoral mobility is defined as "the physical [temporary or permanent] mobility of researchers from one sector (academia in particular) to another (industry in the first place, but other sectors of employment as well) [and return mobility from industry/other sectors back to academia] (Vandevelde, 2014). However, intersectoral mobility can also be considered in a broader context of knowledge exchange through people. This therefore includes the hiring of higher level university graduates and researchers, PhD projects involving placements in private companies, dual career paths in public research organisations (PROs), universities and industry as well as spin-off creation.

There are three main groups of stakeholders in the knowledge transfer process: **business**, **research organisations** and **governmental bodies** and, although not subject of our study, we may also identify a fourth group of actors **– civil society** and the **non-profit sector**. Characteristics of these groups that are interesting for the purpose of this study are **entrepreneurship**, graduate training and public research for the research organisations, **absorptive capacity** and private research for business, and **policy measures** designed and implemented by the governmental bodies.

Academic entrepreneurship refers to economic development initiatives focused on stimulating the commercialisation of technological, social and service innovations developed by academic scientists (Grimaldi et al., 2011; Abreu et al, 2009; Abreu and Grinevich, 2013). The development of academic entrepreneurship is influenced by the extent to which individual scientists and research teams are willing and are incentivised to become involved in the commercialisation of their research results. Academic entrepreneurship is manifested in several forms like university patents, licencing, the creation of academic spin-offs, contract research and consulting, networking with practitioners, staff exchange and joint supervision of students. There has also been a proliferation of technology transfer offices (TTOs), established to enhance the academic

patenting and licensing of results. This report is focused on 1) staff exchange, 2) joint supervision of doctoral researchers, and 3) the setup of university spin offs. While normally studied for their potential impact on the economic development, spin-offs are also clearly tied to the intersectoral mobility as a mechanism through which public sector research staff moves to the private sector.

The concept of **absorptive capacity** is key to the involvement of a firm in a process of collaborative R&D and knowledge transfer. Cohen and Levinthal (1990) argue that the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities. Absorptive capacity can be generated as a by-product of a firm's R&D investment or manufacturing operations. Firms also invest in absorptive capacity directly when they send personnel for advanced technical training or hire new highly skilled staff (Cohen and Levinthal, 1990). A more highly skilled workforce, it is argued, increases the potential to collaborate with outside knowledge producers and users. Literature shows that direct collaboration with scientific partners can give access to tacit scientific knowledge (Cockburn and Henderson 1998), unpublished codified knowledge (Fabrizio, 2009), as well as access to cutting edge scientific equipment (Leten et al. 2012). Hiring highly qualified staff trained in the public research sector and direct collaboration with public sector researchers can bring new knowledge directly to the company, thus reducing the costs involved in the screening, evaluation and assimilation of new knowledge.

Intersectoral mobility, which involves the supply and recruitment of skilled labour by industry, addresses several problems related to the integration of knowledge and skills into a firm's activities. This integration of external knowledge can be a very complex process. Laursen and Salter (2006), following the work of Katila and Ahuja (2002), showed on the basis of innovation survey data of a large sample of manufacturing firms that over-search in terms of depth and breadth (number of sources or search channels) has a negative effect on the performance because it takes too much of the firm's resources. The resources allocated to research could be shifted to employing and integrating a skilled worker that can directly deliver a limited number of solutions. Intersectoral mobility may therefore address the attention allocation problem (Koput 1997), i.e., the abundance of external ideas is difficult to process and acquire, so they need to be given a proper attention in order to be implemented. Knowledge can also be better integrated when knowledge bases are similar (Kogut and Zander 1992) but not too close (Sapienza et al. 2004) as the latter situation can limit the novelty of selected solutions. Attracting highly skilled workers into the company can contribute to finding the right balance between the similarity and difference of internal and external knowledge bases.

Governments implement intersectoral mobility programmes allowing companies to access new knowledge by contracting students and researchers from public research centres and universities. In most European countries legal and administrative measures are in place to facilitate the intersectoral mobility of researchers. Governments can play a role in facilitating, promoting and funding placements for researchers, i.e., researchers spend a limited period of time in other sectors in order to gain sector-specific experience and share research expertise. Those policies could be regarded as "soft measures" which could potentially have long-lasting effects on researchers' employability, employers' perception of sources of innovation and the use of outside knowledge as well as the mindset of academics by introducing a commercial perspective to their research, and finally, trigger long-term collaborative activities.

The literature evaluating intersectoral mobility policies and presenting insights into outputs and the impact of such measures is growing. Scholars analyse additionality effects in terms of innovation efforts and capabilities of firms (Herrera et al,(2010); Martinez et al. (2015)), salaries and employment of R&D workers (Thomson and Jensen, 2010), the overall role of researchers in stimulating knowledge transfer (Levy, 2005) or exploring the European community innovation survey (CIS) to investigate the firms co-

operation patterns (Tether, 2002). Different approaches are used to measure the impact of intersectoral mobility, relying both on qualitative and quantitative assessments. Indicators used include: level of R&D investment (in-house, from external sources and total), propensity to patent, innovative firms cooperating with external partners, researchers employed by sector, level and sector of employment of PhDs. Results from the empirical studies confirm the positive effect of intersectoral mobility. However, they also point to some constraints and unknowns which can limit the potential benefits from intersectoral mobility (Herrera, 2010).

This report investigates policy efforts at country level. By analysing relevant policy instruments and their evaluations, the report aims to address the following research questions:

1. *Which are the most commonly used measures to support intersectoral mobility in the Member States?*

2. *To what extent are the intersectoral mobility policy measures evaluated and how?*

3. *What is the evidence of the impact of intersectoral mobility policy instruments based on those evaluations?*

   - *And more specifically, how is the effect of the policies measured – what are the input, output/outcomes and impact indicators?*

3 Quantitative assessment of EU countries performance in knowledge transfer and intersectoral mobility

The EU Member States show stark differences in performance on a number of widely adopted knowledge transfer (KT) indicators. While acknowledging the fact that a mere quantification of KT activities may lead to a biased assessment of a KT system's effectiveness, this section provides a more general picture of the EU Member States' performance in order to place the rest of the analysis into context. This section is based on a series of indicators which are described in more detail in Annex 1. This Annex provides an overview of the Member States' performance on three additional indicators: innovative firms' cooperation patterns (CIS, Eurostat); publicly performed R&D financed by the business sector (Eurostat), and public-private co-publications (Scopus, Scival). The Annex also provides some methodological background for the figures on inter-sectoral mobility presented in this section.

When considering the share of **companies reporting collaboration with universities or public research organisations**, one observes that there is no clear distribution between the countries on the basis of overall innovation performance. The innovation leaders and innovation followers in general have a relatively high level of performance on the extent to which companies collaborate with academia. A notable exception, however, is Germany where this type of collaboration is relatively low. Especially the UK, Belgium and Austria show relatively high levels of academia-business interaction. The moderate and modest innovators tend to score lower on this indicator, but there are a number of exceptions including Cyprus, Lithuania, Estonia, Hungary and Slovakia, which score higher rates than some of the leading innovators. Another frequently used indicator of knowledge transfer activities is the share of **public R&D directly funded by the business enterprise sector** as a share of the gross domestic expenditure on R&D (GERD). Again the picture that emerges from the figures is mixed, but not in the same way as for the first indicator. While for Germany a small share of companies reported to depend on universities or PROs, the relative volume of business funding to these organisations is the highest in Europe[4]. Other differences include the relatively low share of British business funding of public R&D and the very high score of such funding in Lithuania. The number of **public-private co-publications** as share of the total number of publications by contrast provides a fairly straight-forward picture. The innovation leaders and innovation followers clearly show high shares whereas the moderate and modest innovators score below the EU28 average.

This brief description of the relative performance across the EU Member States on KT indicators leads to the conclusion that the KT process is multifaceted and difficult to capture by a single indicator. Thus it is important to consider multiple indicators in combination, but due to the big variation in the performance of the EU Member States on the three indicators it is difficult to draw clear conclusions on the relative KT performance of the different countries.

[4] A potential explanation for this observation is that in Germany, the Fraunhofer institutes stand out as a major contributor to translational research.

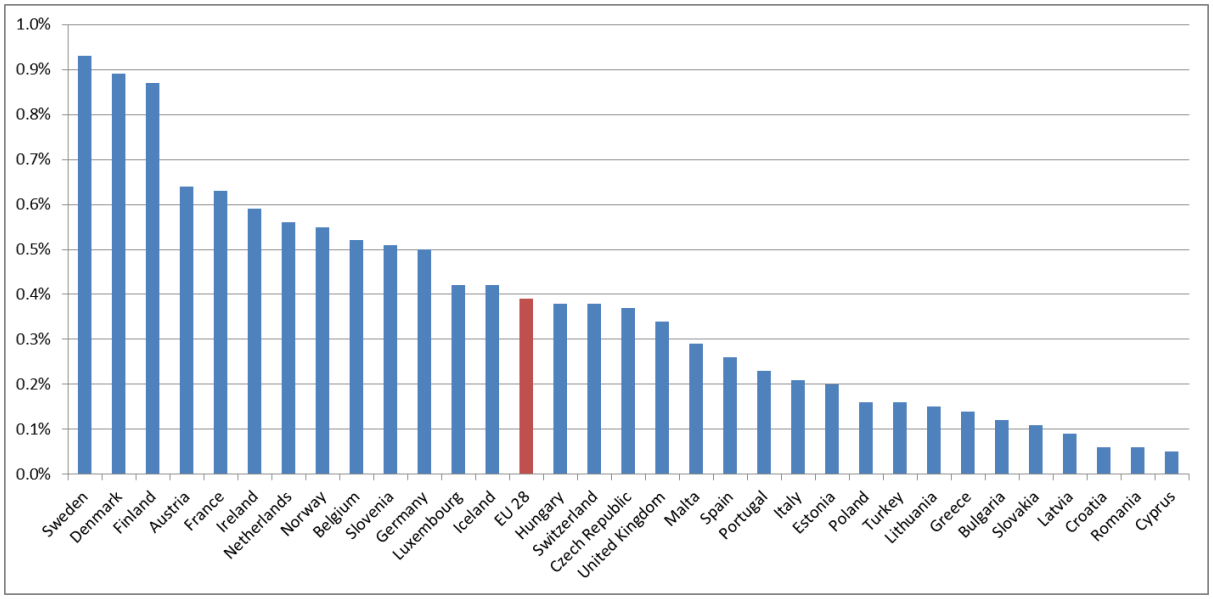

Figure 1 Countries according to the number of researchers employed in industry as share of total employment (Eurostat, 2016)

The number of **researchers employed in industry** as share of total employment (Figure 1) may be considered as an indicator of past intersectoral mobility and absorptive capacity of the firms[5] in the different EU Member States. It is also an indicator of the investment of governments in PhD training. If the number of PhD candidates funded exceeds the turnover of academic personnel, a surplus of researchers is available for the non-academic labour market. One observes that leading innovators such as Finland, Sweden and Denmark have relatively high levels of full time equivalent (FTE) researchers employed in the business sector. This partially reflects the structure of their economy with a relatively high share of knowledge intensive sectors (such as high-tech manufacturing or financial services). Germany, however, rates close to the EU average.

The MORE 2[6] survey of doctorate holders currently employed in the Member States universities shows that the **mobility of doctorate holders** to industry and back to academia[7] is particularly high in Bulgaria, Hungary, Greece, Cyprus and Poland (Figure 2). This suggests that these countries may be less in need of policy instruments stimulating temporary intersectoral mobility, as this process already occurs at high levels. Alternatively it may be due to the relative unattractiveness of industry employment compared to academic employment. The permanent recruitment of researchers by the business sector (see Figure 1) remains at relatively low levels which may also impact on the propensity of researchers to choose university employment. Therefore, there remains a rationale in these countries for measures supporting intersectoral mobility. Among knowledge intensive economies such as those of Switzerland, Denmark, the Netherlands and Belgium, the levels of temporary intersectoral mobility (as measured by MORE 2) are relatively high. In some countries, such as Italy, Portugal, Slovakia and Romania, the indicators of both permanent and temporary mobility from the public to the private sector have low values. This is also true for France concerning the indicators for temporary mobility derived from the MORE

[5] See also Annex 1

[6] ec.europa.eu/euraxess/pdf/research_policies/more2/Final%20report.pdf

[7] A limitation of the MORE II study is that the sample only covered doctorate holders working in universities. Respondents must thus have returned to academia when taking part in the survey.

II study. In terms of the share of researchers employed in industry, France scores well above the EU average. One explanation for this observation is that the Eurostat definition of researchers includes engineers[8] and that in France (as well as in some other countries) engineers play an important role in private sector research.[9] Another reason could be that academia is relatively closed to the reintegration of researchers with business experience[10].

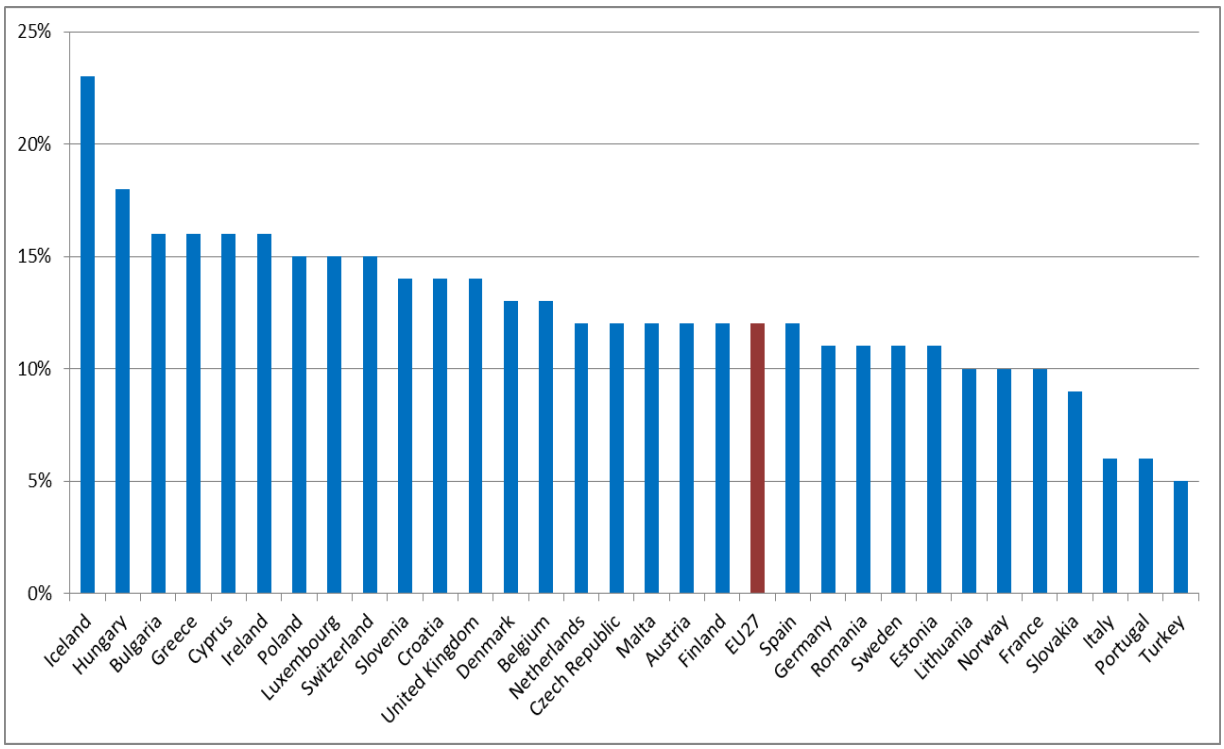

Figure 2 Intersectoral mobility to private industry (per country)

Data: MORE2 HEI survey (2012)

Report: IDEA Consult et al, 2013. MORE2 - Support for continued data collection and analysis concerning mobility patterns and career paths of researchers, HEI report (WP1). European Commission, DG Research and Innovation.

The MORE 2 study focuses on researchers currently employed in academia and therefore gives only a partial view of the intersectoral mobility of researchers. We adopt the measure "researchers employed in business" as an indicator[11] of mobility from the public to the private sector as well as the absorptive capacity of private sector firms. In general the performance of countries on this indicator is in line with indicators like business R&D intensity and a number of the broader KT indicators presented in Annex 1.

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[8] "**Researchers** are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned" (OECD Frascati Manual, 2002).

[9] https://www.researchprofessional.com/0/rr/news/europe/france/2016/3/PhD-holders-play-second-fiddle-to-engineers-in-French-industry.html

[10] http://www.eui.eu/ProgrammesAndFellowships/AcademicCareersObservatory/AcademicCareersbyCountry/France.aspx

[11] See definition for "researchers" above. In addition, several studies acknowledge that the employment of university researchers is an effective way to transfer knowledge from universities to firms (Zucker et al., 2002; Gübeli and Doloreux, 2005). See Annex 1 for more information

4 Methodological approach

Evaluations can be viewed as case studies of the impact of individual R&I policy interventions. This report follows Ebersberger et al. (2006) in arguing that a combined analysis of evaluations can provide us with an insight beyond specific policy interventions. Through the approach outlined in this section, the intention is to analyse the impact of different types of policy initiatives. The combined use of existing evaluations to come to a more grounded assessment of the effectiveness of types of policy interventions knows a considerable history and is being used to inform R&I policy (Ebersberger et al, 2006; Edler et al, 2008; Gok and Edler, 2012), education policy (e.g. Scriven, 2009), developmental aid (e.g. Olsen & O'Reilly, 2011; The Copenhagen Consensus, 2016[12]) and health policy (e.g. Greenalgh, 2004).

The emergence of systematic evaluation has accompanied the development of R&I policy making since the 1980s (Georghiou,[13]). A first step in the analysis of R&I policy evaluation was made by the OECD in 1997[14] in order to compare approaches and identify best practices in R&I policy evaluation (Papaconstantinou and Polt, 1997, followed among others by the JRC IPTS in Fahrenkrog et al, 2002). Based on R&I evaluation reports collected through several EU funded programmes (INNO-appraisal (Edler et al, 2010) followed by SIPER), a literature is emerging, which seeks to exploit existing evaluations to address questions regarding the nature and quality of evaluations of R&I policy measures carried out in the member states, the nature of evaluations themselves in the R&I realm (Edler et al, 2012; Gok and Edler, 2012), their impact on the policy making process, R&I policy performance at the system level (Edler et al, 2008; Ebersberger et al, 2006) and, most relevant for this study, to gain an insight in the impact of specific types of policies beyond the singular cases to which individual evaluations are applied (Edler et al, 2008, Ebersberger et al, 2006).

Evaluation synthesis is best understood as a content analysis of multiple evaluation reports on similar programmes or projects in the field of evaluation of interest. Such a synthesis is, in contrast to a meta-analysis in which the data from a larger number of evaluations are "re-analysed" to increase the number of cases, mainly based on the key messages from the evaluation reports and thus does not directly rely on the raw data on which these evaluations are based (Bewyl & Associates, 2016; Ebersberger et al, 2006)[15]:

Figure 3 provides a schematic overview of the research design and the approach taken.

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[12] http://www.copenhagenconsensus.com/bangladesh-priorities

[13] http://www.oecd.org/sti/inno/1907894.pdf

Papaconstantinou G, Polt W. *1997. 'Policy Evaluation in Innovation and Technology: An Overview'. in Proceedings from OECD Conference on Policy evaluation in innovation and Technology, Paris 26–27 June 1997 < http://www.oecd.org/sti/inno/1822393.pdf > accessed May 2016.*

[15] http://eval-wiki.org/w_glossar/index.php?title=Kategorie:A_bis_Z&pagefrom=Meta-Evaluation#mw-pages

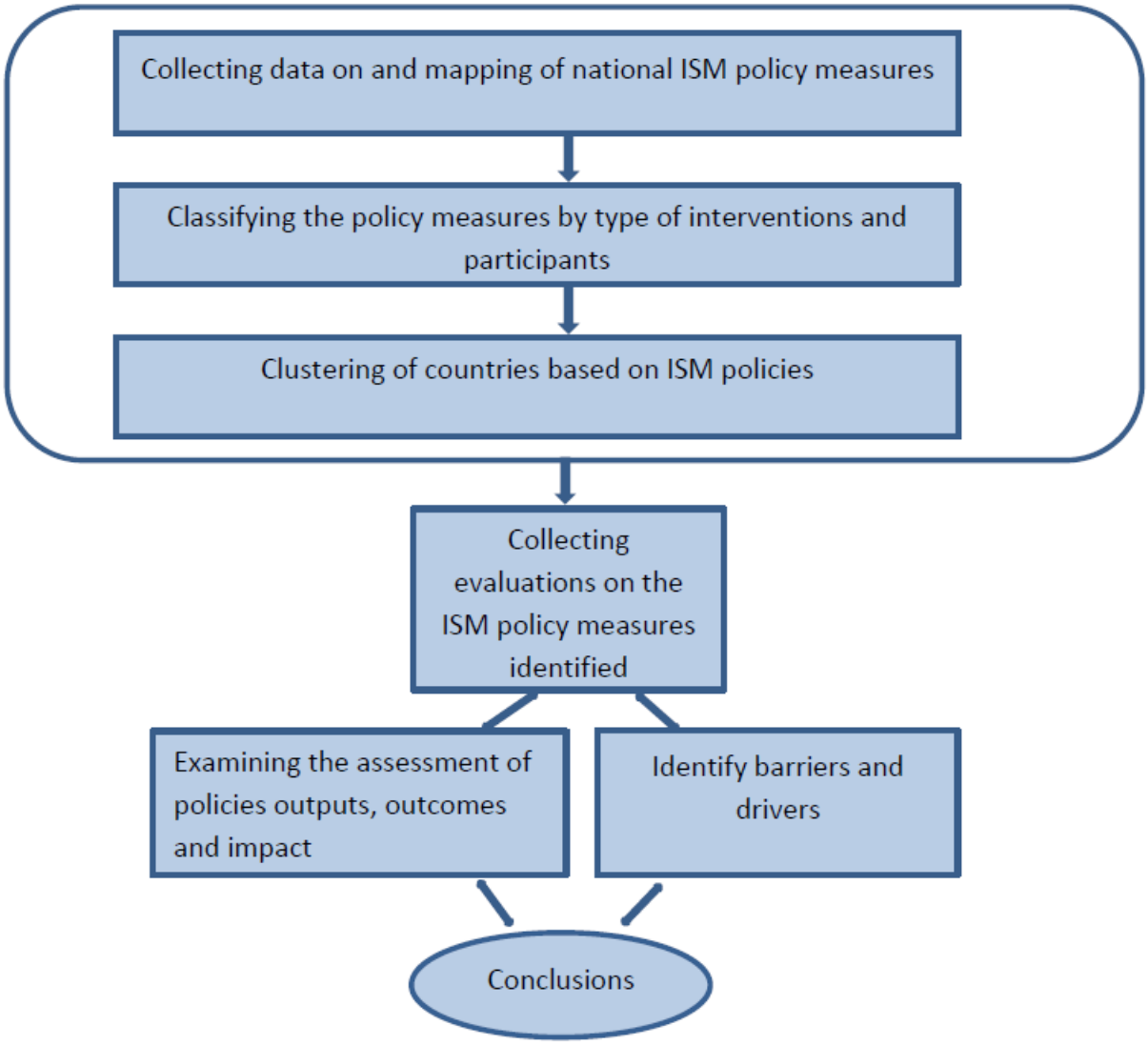

Figure 3 Scheme of the methodological approach used for the purpose of the report

A first phase is to come to a broad and comprehensive overview of the national policy measures taken in the Member States (with the exception of Belgium where the research and innovation policy is devolved to regions) to promote the short and long term intersectoral mobility of academic researchers to industry (and potentially also in the other direction – from industry to academia). It should be noted that there is a wealth of policy measures implemented on a regional level, by individual universities and companies.

The national policy measures in all Member States are identified and classified according to the type of interventions and beneficiaries.

Countries are then grouped applying a two-step classification:

1) The countries are grouped into two groups based on the number of intersectoral mobility measures.
2) Within the groups identified, the countries are divided into two groups – above and below EU-28 average -based on the number of researchers employed in industry as share of total employment

The result is a matrix of 6 country groups.

The national policy measures are identified on the basis of the following sources:

- RIO Country Report series 2014 covering 28 Member States and 2015 series covering 28 Member States and five associated countries (Iceland, Israel, Norway, Switzerland, Turkey)[16]
- The DG RTD commissioned Researchers' Report 2014[17]
- Complementary desk research

The second phase involved more in depth analysis of those policy instruments, whose impact has been evaluated by the Member States. We collected data on the selection of policy measures, using readily available evaluation reports of intersectoral mobility schemes. The main source of the evaluations is the SIPER database[18], which is complemented by desk research and information from the Research & Innovation Observatory (RIO) policy repository[19]. In view of the limited search outcomes, the analysis also includes additional sources, such as self-evaluations, progress reports and scientific articles, which evaluate more than one scheme.

Although there have been important policy initiatives, evaluating their success is difficult, because there is little agreement as to what evaluation method is appropriate. Moreover, there is no easy way to measure the counter-factual of what would have occurred if these initiatives had not been implemented (Grimaldi et al., 2011).

The evaluations used in this study vary considerably in their design, nature and the input and output variables they use. The report aims to both do justice to some of the breadth of the evaluations covered and to zoom in into a number of shared elements. Clearly, there are many challenges regarding the use of evaluation reports to assess the impact of intersectoral mobility measures. In terms of coverage, the evaluations are very scarce: only a limited number of documents have been identified. Moreover, the evaluations differ in approaches, scope, metrics used, etc. This makes it even harder to build a comprehensive picture for benchmarking and comparison across countries. This heterogeneity also limits the extent to which the data sources can be used to draw robust conclusions about the effect of the respective types of policy instruments. Nevertheless, the evaluations represent a valuable source of information which allows us to grasp the complexity of the whole process.

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[16] https://rio.jrc.ec.europa.eu/en/country-analysis

[17] http://ec.europa.eu/euraxess/index.cfm/services/researchPolicies

[18] SIPER (Science and Innovation Policy Evaluations Repository) database is a central source of knowledge on research and innovation policy evaluations. Its aim is twofold: to provide on-line access to a unique collection of policy evaluation reports, located at a single location; to allow policy learning by providing an informed analysis of the database contents in a way that is both searchable for policy makers and other stakeholders and provides the basis for additional academic analysis.

[19] Research and Innovation Observatory (RIO) is an initiative of the European Commission to monitor and analyse research and innovation developments at country and EU levels to support better policy making in Europe. R&I documents are stored here: https://rio.jrc.ec.europa.eu/en/library

5 Analysis of intersectoral mobility policy measures

The large scale mapping of the national policy measures (based on the sources described in the previous section quantifying the number of measures without in-depth analysis of their scale and amount of funding) in the Member States showed that the main types of policy interventions are focused on bringing skilled personnel to the business sector and only sporadically to other sectors (non-profit or government). We have not identified specific national policy measures focused on bringing back researchers to academia[20] but some measures do not specify the direction of the mobility and allow for both directions. The mapping does not include policy measures targeting mediating/intermediary structures such as Research and Technology Organisations (RTOs) that may also support intersectoral mobility but have not been created for this purpose. We have, however, included regulations supporting intersectoral mobility (see annex), but as such instruments are rarely evaluated, they were not taken into account in the analysis.

The results of the policy measures mapping is as follows:

Member States: 17 Member States have 3 types of policy measures; 8 Member States have 1-2 types; 2 Member States do not have any relevant measures;

Associated countries: 3 countries have each 3 measures, 1 country has only 1 measure, and 1 country has no measures.

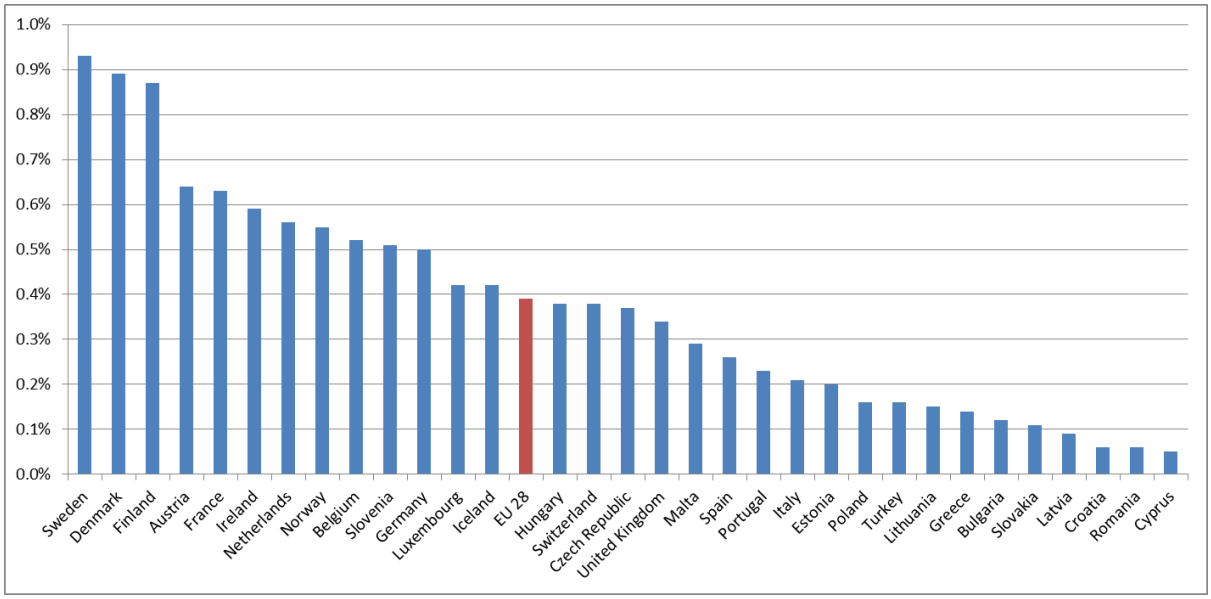

Figure 4 Countries according to the number of researchers employed in industry as share of total employment (Eurostat, 2016)

As discussed in the section on methodology, the countries are grouped according to the number of researchers employed in industry as share of total employment (see figure 4) and the number of policy measures related to the intersectoral mobility that are in place.

[20] At the EU level the MSCA programme does have an instrument with this objective.

Table 1 Country grouping based on the number of researchers employed in the business sector and range of intersectoral mobility measures

	Above EU-28 average level of researchers employed in the business sector	**Below EU-28 average level of researchers employed in the business sector**
Countries with a wide range of ISM measures (all three types)	AT, BE, DE, DK, FR, IE, NO, SE,	BG, HR, EL, ES, HU, IT, LT, PL, PT, TR, UK
Countries with limited number of ISM measures (1-2)	FI, LU, NL, SI	CH, CY, EE, MT,SK, RO ,
Countries with no ISM measures	IS	CZ, LV

Countries with a wide range of measures

One observes that most countries, both those with high and lower levels of business employment of researchers, have implemented a broad range of policy instruments to promote intersectoral mobility. The Netherlands, Finland and Slovenia have not implemented as broad an array of measures but do have relatively high levels of business employment of researchers. Two Member States (**Czech Republic and Latvia**) and one associated country[21] (**Iceland**) do not yet have any measures specifically targeting intersectoral mobility of researchers. Slovakia and Slovenia have discontinued measures aimed at intersectoral mobility. Slovakia has not implemented new ones and Slovenia merged the measure in a programme funded by the European Social Funds "Strengthening R&D departments in business enterprises (KROP)" .

Cluster 1 – Above EU-28 average level of researchers employed in business sector and wide range of ISM measures

- **Austria** has introduced quite a variety of mobility schemes including an Industrial PhD Programme, Young Experts programme targeted at PhD students and PhD holders and a specific programme targeting women researchers (FEMtech Career Paths). The country has introduced also two measures aimed at the creation of spin-offs (AplusB - Academia plus Business and Phoenix Award).
- **Belgium,** given its regional competences in the area of R&I, has a wide range of measures such as PhDs targeted Baekeland Mandates in Flanders, Doctiris in Brussels Capital, and PRODOC programme in Wallonia. Wallonia has also a FIRST Higher Education Institutes measure targeting researcher and Flanders support research take up by industry through R&D tax credits and Flanders support research take up by industry through R&D tax credits and Beware Fellowships. All three regions support spin-offs creation (Spin-off Mandates in Flanders, the Industrial Research Fund for universities (in Flanders), Spin-off in Brussels, and First spin-off in Wallonia).
- **Denmark** has a long standing tradition in an Industrial PhD programme (since

[21] **Israel,** for which we do not have data about the number of researchers, runs two programmes supporting PhDs – MAGNET and Nofar. The National Programme supporting the Return of Israeli Academics also assists the Israeli industry to absorb qualified personnel. The Young Entrepreneurs scheme supports the creation of spin-offs.

1994) and introduced also an Industrial Post-doc measure fairly recently (2011). Both programmes have been evaluated and the results are used subsequently in this study.

- **Germany** offers a number of measures, including Industrial PhDs, Fraunhofer Attract Programme aimed at researchers, and Fraunhofer Institutes Shared Professorship programme. The spin-offs are supported through Helmholtz Enterprise, High-tech Start-up Fund (High-tech Gründerfonds) and EXIST - University-Based Business Start-Ups programme, which has been evaluated.
- **France** is one of the Member States with a long lasting PhD intersectoral mobility programme (since 1981) - CIFRE fellowship. It also supports in a wider context researchers uptake in industry through the research tax credit (CIR). Finally it has introduced a spin-off policy measure - JEU-JEI and PEPITE programme.
- **Ireland** offers PhD students an IRC Employment-based Postgraduate Programme and seasoned researchers can choose between many programmes, including SFI Industry Fellowship Programme, the loan of qualified personnel (for SMEs), Enterprise Partnership Scheme, Elevate SFI Short-term Industry Visiting Fellowship. Enterprise Ireland New Frontiers Programme supports the creation of spin-offs.
- **Norway** runs since 2008 an Industrial PhD scheme and evaluated it in 2012. In 2016 the country has introduced a new pilot scheme for support to students and PhDs who want to engage in entrepreneurship.
- **Sweden** runs two schemes targeted at PhDs - Company graduate schools (Företagsforskarskolor) and Industrial PhD project (Industridoktorand projekt - ID-projekt). Four different schemes were put in place to facilitate the uptake of researchers by the private sector (Development of the Knowledge Triangle; Mobility for Growth; VINNMER; FLEXIT)

Cluster 2 – Above EU-28 average level of researchers employed in business sector and limited number of ISM measures

- **Finland** supports researchers' mobility on national level through Academy Project funding.
- **Luxembourg** offers Public-Private Partnerships under the AFR (Aides à la Formation-Recherche) for PhD researchers.
- **The Netherlands** supports the uptake of researchers in business through the Kenniswerkers programme.
- **Slovenia** supported PhD students through the scheme Young researchers in the business sector (closed in 2010) and PhD holders through the Call for strengthening R&D departments in business enterprises (KROP), Interdisciplinary teams in the business sector and Mobility grants for researchers from public sector to enter business enterprises. None of those schemes are available in the current programming.

Cluster 3 – Below EU-28 average level of researchers employed in business sector and wide range of ISM measures

- **Bulgaria** has so far introduced two measures aimed at PhD students - Stipends for doctoral students preparing their theses in a national company and Industrial PhDs. It finances also the spin-off creation through the Tehnostart programme - Encouraging the innovation activity of young people in Bulgaria.
- **Croatia,** within its Operational Programme Human Resources Development, supports PhD students' mobility, and has introduced a specific intersectoral policy measure Young Researchers' Career Development Project – Training of Doctoral Students. It has also specific measures for PhD graduates - NEWFELPRO and spin-off creation (PoC PUBLIC).
- **Greece** has used the structural funds (2007-2013) to support enterprises in recruiting high-level scientific personnel and to encourage spin-off creation through the Creation programme.
- **Hungarian** researchers can use the industry sponsored PhD programmes, as well as Kozma László and 5LET/IDEA support researchers mobility to industry. New Hungary Venture Capital Programme supports the creation of spin-offs.
- **Italy** has introduced a national measure PhD ITalents and high level apprenticeship contracts are offered by regions. The uptake of researchers in business is also supported by a tax credit for hiring 'highly-qualified' personnel.
- **Lithuania** has just introduced the PhD doctorates scheme (2015). A previous scheme, State Support for Employment of skilled personnel in companies, has attracted only a few companies and researchers (17 researchers and 4 companies). The country is running also a couple of schemes targeting spin-offs (Technostart, INOVEKS, and Joint initiatives since 2016).
- **Poland** offers a scheme for PhD students allowing them to engage in internships in business (SKILLS Impuls). It has also introduced a pilot scheme of short term placements KadTech but there has been little interest in it (only two companies granted support). Nevertheless, the regions run a similar, albeit more successful, TEKLA programme that allows for both directions of mobility (from and to academia). Recently, Poland has introduced also a set of measures aimed at spin-offs, including BRIdge Alfa.
- **Portugal** runs since 2008 a doctoral degree grants in enterprises BDE scheme. It also supports PhD holders through a similar measure (Mobility grants between R&D institutions and enterprises or other entities - BMOB (bolsa de Mobilidade)).
- **Spain** runs schemes for both PhD students - Industrial PhDs (PECTI), and experienced researchers - Torres Quevedo programme. It also supports spin-offs through EMPLEA and NEOTEC schemes.
- The **UK** runs schemes supporting PhD students (Industrial CASE, Knowledge Transfer Partnerships (KTP), Doctoral Training Centres). It also supports PhD holders to gain experience in industry through Support to Secondments: Knowledge Transfer Secondments, Knowledge Transfer Networks and dedicated industry fellowships (e.g. Royal Society). The UK has long lasting intersectoral mobility measures, which are frequently evaluated.
- **Turkey r**uns an Industrial Thesis Supporting Programme (SAN-TEZ). The Technology Development Zones (TDZs) programme provides specific tax incentives to spin-offs.

Cluster 4 – Below EU-28 average level of researchers employed in the business sector and limited number of ISM measures

- **Cyprus** has supported young researchers through the PENEK programme and placements of students in industry through the network of Industry Liaison Offices.
- **Estonia** supports PhD mobility through DoRA programme (currently DoRa Plus) and researchers' mobility through the Competence Centres. The SPINNO programme supports the creation of spin-offs.
- **Malta** supports the researchers' uptake in business through the Loan of Qualified Experts and restricts its support to SMEs only.
- **Romania** has used structural funds to support Mobility projects for PhDs and secondments to SMEs. In the current programming period, Romania plans to run a Competence centres scheme which will also support PhDs uptake in industry.
- **Swiss** CTI Entrepreneurship (formerly Venturelab) provides courses and training for academics in entrepreneurship and the Swiss university system is very active in promoting and launching start-up initiatives.

Cluster 5 – Above EU-28 average level of researchers employed in business sector and no ISM measures

- **Iceland**

Cluster 6 – Below EU-28 average level of researchers employed in business sector and no ISM measures:

- **Czech Republic**
- **Latvia**

As we can see from the country grouping presented above, the share of researchers employed in business is not correlated with the number of measures in place in a given country.

The EU-13 countries in general have deployed the measures quite recently and on a pilot basis. It would be interesting to explore why Slovenia and Slovakia have decided to discontinue the measures.

The mapping of policy measures shows that there are three main types of mobile personnel supported through the policy measures – recent graduates of higher education institutions, PhD students, and researchers (most often already holding a PhD title).

As far as the policy interventions are concerned, one can distinguish between:

- graduates supported by offers of subsidised placements and tax credits covering their salaries;
- PhD students' mobility supported through internships, entrepreneurship skills training and industrial PhD programmes;
- researchers from academia benefiting from short-time placements, entrepreneurship trainings and tax credits that alleviate the costs of companies in recruiting highly skilled personnel;
- fellowships, industrial chairs and dual path career regulations supporting the industry researchers' mobility to academia (those measures are rarely

implemented on the national level, they are rather introduced by universities in a partnership with industry);

- specific subset of measures that support the stemming of new knowledge-based firms from research organisations, the so called spin-offs. The latter is a channel for the mobility of university/PROs staff to the private sector as well.

Figure 5 provides a schematic representation of the types of policy instruments EU Member States have adopted with the aim to increase knowledge transfer through short and long term intersectoral mobility of public sector researchers to the private sector.

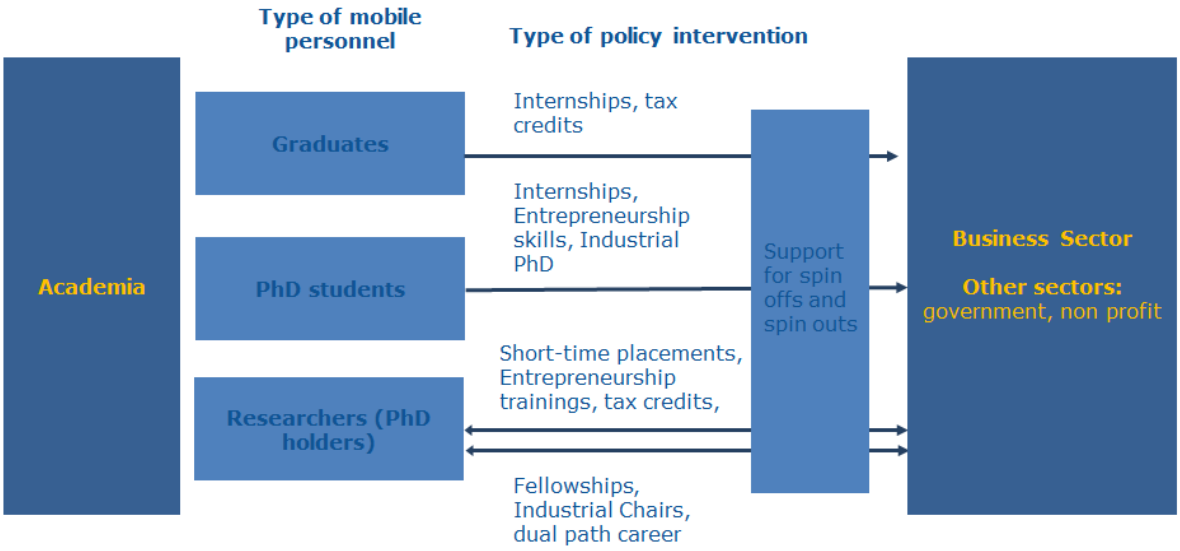

Figure 5 Intersectoral mobility measures by type of personnel and policy intervention

The majority of the Member States have introduced at least one measure focused on the support of the uptake of researchers in industry and most EU-13 countries that have not done it yet are planning such measures in the current programming period financed from the structural funds (e.g., the Czech Republic).

The mapping shows that the most often implemented types of policy interventions are:

- Funding and regulatory support for Industrial PhDs and industrial traineeships;
- Post-doctoral researchers placements (Industrial Post-Docs and other similar measures) stimulating the uptake of PhDs by private sector firms/SMEs;
- Support measures for creating spin-offs.

For those types of measures available evaluations have been identified. The subsequent chapter presents an analysis of their outcomes.

Table 2 Summary table of intersectoral mobility policy measures

MS	Industrial PhDs and industrial traineeships	Uptake of PhDs by private sector firms/SMEs	Academic entrepreneurship and spin offs /spin-ins
Austria	x	x	x
Belgium	x	x	x
Bulgaria	x		x
Croatia	x	x	x
Cyprus	x	x	
Czech Republic			
Denmark	x	x	
Estonia	x	x	
Finland		x	
France	x	x	x
Germany	X	x	x
Greece		x	x
Hungary	x	x	x
Ireland	x	x	x
Italy	x	x	x
Latvia			
Lithuania	x	x	x
Luxembourg	x		
Malta		x	
The Netherlands		x	x
Poland	x	x	x
Portugal	x	x	
Romania	x	x	
Sweden	x	x	
Slovakia		X	
Slovenia	x	x	
Spain	x	x	
United Kingdom	x	x	
Switzerland			x
Israel	x	x	x
Iceland			
Norway	x	x	x
Turkey	x		x

6 Analysis of the impact of intersectoral mobility measures based on evidence from the evaluations

In this section we examine the demonstrated outputs, outcomes and socio-economic impact of the policy measures targeting intersectoral mobility. To do so, we went through a thorough search for available evaluations and a selection process.

We focus on three main sources to assess the impact of the policy instruments:

- external evaluations;
- self-reported assessments (progress reports, internal evaluations);
- scientific literature analysing specific intersectoral mobility policies.

The retrieved documents were studied for 1) evidence on the impact of selected policy measures, 2) methodologies used for the evaluations, and 3) lessons learnt when implementing the measures.

The evaluations of intersectoral mobility schemes that we were able to identify (given the language restriction our search was based mostly but not entirely on English, French and German language sources) proved to be rather scarce. In total, we have found 19 evaluations covering nine countries (eight EU Member States and Canada) for the three aforementioned types of measures.

Table 3. Evaluations of intersectoral mobility measures

Industrial PhD programmes	Post-doctoral researchers placements	Support measures for creating spin-offs
9 evaluation reports and surveys and two research articles	6 evaluation reports	3 evaluations and 3 scientific articles.
UK (Industrial CASE scheme), Denmark (Industrial PhD programme), France (CIFRE fellowships), Slovenia (Young researchers from the business sector) and Sweden (Industrial PhD projects).	Austria (FEMtech Career Paths), France (Crédit impôt de recherche), Poland (TEKLA+), Sweden (Flexit). These were benchmarked with the Canadian experience (Industrial R&D Fellowships) since the design of this measure was similar, the evaluation appeared to be of good quality and was publicly available.	Austria (AplusB – Academia plus Business), Germany (EXIST – University-based business start-ups) and Belgium (FIRST Spin-off)
19 evaluations for 9 countries		

Evaluation of the impact of supporting policies

a. Industrial PhDs and industrial traineeships: Innovative Doctorate Training

Policy measures promoting the linkages between business and academia through PhD candidates' traineeships in the private sector are among the most wide spread ISM measures in the EU28 Member States and the associated countries. They usually take the form of an "Industrial PhD" or other type of related training/apprenticeship programme for doctoral candidates in the business sector (i.e., "Young researchers" programmes). One of the main features of the industrial PhD schemes is that they span

two cultures: the students are placed in a company while at the same time they pursue doctoral studies at a university.

Country	Type of the scheme	Title of the evaluation
Denmark	Industrial PhD Programme	The Industrial PhD - an effective tool for innovation and knowledge sharing (Summary of analyses and studies), 2007[22] Analysis of the Industrial PhD Programme, 2011[23]
France	CIFRE fellowships	Les doctorants CIFRE : médiateurs entre laboratoires de recherche universitaires et entreprises (Article), 2005[24] Enquête sur le devenir professionnel des docteurs ayant bénéficié du dispositif Cifre l'année 2000 (Survey), 2012[25]
Slovenia*	Young researchers in the business sector	Effectiveness of the actions of the Ministry of Higher Education, Science and Technology to promote innovation and technological development of Slovenian companies in the years 2005-2007, 2010[26] ERAC Policy Mix Peer Reviews: Country Report Slovenia, 2010[27]
Sweden	Industrial PhD projects	Planning Industrial PhD projects in practice: speaking both 'academia' and 'practitionese' (Article), 2011[28]
United Kingdom	Industrial CASE Knowledge Transfer Partnerships	Evaluation of Biotechnology and Biological Sciences Research Council (BBSRC) Industrial CASE scheme, 2012 & 2013 [29] ; Natural Environment Research Council (NERC) CASE Studentship Review[30] Knowledge Transfer Partnerships (KTP) Strategic Review, 2010[31]

**The scheme was discontinued as a separate measure. It was merged into a EUSF funded programme "Strengthening R&D departments in business enterprises (KROP)"*

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[22] http://ufm.dk/en/publications/2007/the-industrialphd-an-effective-tool-for-innovation-and-knowledge-sharing
[23] http://innovationsfonden.dk/sites/default/files/analysis_of_the_industrial_phd_programme.pdf
[24] Levy Rachel. Les doctorants CIFRE : médiateurs entre laboratoires de recherche universitaires et entreprises. In: Revue d'économie industrielle, vol. 111, 3e trimestre 2005. pp. 79-96.
[25] http://www.anrt.asso.fr/fr/espace_cifre/pdf/Enquete-devenir-professionnel-docteurs-Cifre.pdf
[26] The document is available in Slovenian: http://www.arhiv.mvzt.gov.si/fileadmin/mvzt.gov.si/pageuploads/MSZS/GradivoSZT/2._seja/POROCILO_CRP_Ucinki_ukrepov_za_Direktorata_za_tehnologijo_MVZT.pdf
[27] http://www.arhiv.mvzt.gov.si/fileadmin/mvzt.gov.si/pageuploads/pdf/znanost/ang_verzija/Slovenia_OMC_Report-FINAL_dec.pdf
[28] DS 68-8: Proceedings of the 18th International Conference on Engineering Design (ICED 11), Impacting Society through Engineering Design, Vol. 8: Design Education, Lyngby/Copenhagen, Denmark, 15.-19.08.2011
[29] http://www.bbsrc.ac.uk/documents/1306-ind-case-evaluation-report-pdf/; http://www.bbsrc.ac.uk/documents/icase-evaluation-conclusions-pdf/
[30] http://www.nerc.ac.uk/funding/available/postgrad/focused/industrial-case/case-review/
[31] http://www.techuk-e.net/Portals/0/Content/ValleyofDeath/KTP%20Strategic%20Review.pdf

In most of the countries where evaluations of Industrial PhD programmes were found, the measures are well-established and embedded in the policy mix. For example, UK's Industrial CASE scheme was introduced in 1994, in France the scheme dates back to 1981 and in Denmark to 1970.

In general, the evaluations prove that the schemes are beneficial to all parties involved. The reports focus on different outputs and impacts of measures depending on the design of the measures. Most of the evaluations focus on the impact on the career [prospects] of the participants and their labour market situation, the benefits for the companies and the economy. Some evaluations focus on the formal and informal interaction between the parties involved, such as networking and further mobility of staff (at the post-doc level).

The following paragraphs explore the impact of the programmes reported in the evaluations, distinguishing between the impact on individuals (PhD candidates), private companies and public research organisations and on the R&I system as a whole. Possible drawbacks and incentives to participate in intersectoral mobility schemes as well as recommendations for improvement of the policies were also examined.

Quality of training

In most cases, the evaluations survey the quality of the training provided by both industry and universities. While the "bi-cultural" aspect of the programmes is generally praised by all, the perceptions of the training received vary. In some cases, the training provided by academia is better appreciated compared to that provided by industry (UK's CASE) and in other cases (e.g., Danish Industrial PhD Programme) participants tend to favour the industrial training.

The UK's CASE survey [32] reports that similar proportions of both the students and academic supervisors rated the quality of training as good or very good in all categories but one (i.e., commercial and entrepreneurial awareness). The quality of training provided by industry partners was more variable than that provided by academia, which in general was rated more positively by participants. In addition, the evaluation raises a potential concern, i.e. that industry placements (or other types of interactions) are not recognised as training by some students[33].

Denmark – the industrial PhD Programme[34]

The Industrial PhD Programme was conceived already in 1970 as a 2-year course and in 1989 – redesigned as it is now to a 3-year doctoral programme. The aims of the programme are: increasing the number of PhDs, intensifying knowledge circulation between academia and business, promoting research with commercial perspectives, and taking advantage of competences and research facilities in the industry.

The Danish industrial PhD programme has been evaluated regularly. High levels of satisfaction are observed among all the participants – candidates, universities and industrial partners. More PhD students are satisfied with the collaboration with enterprises (92.5% are extremely or somewhat satisfied) than with the university supervisor (86.4%).

All evaluations studied draw the general conclusion that the industrial doctoral programmes have provided the participants with the opportunity to tap into knowledge and specific expertise from industry and provided hands-on training.

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[32] Evaluation of BBSRC's Industrial CASE scheme, June 2013 – pp.17-20

[33] Potential drivers, barriers and recommendations are examined to a certain extent at the end of the section

[34] http://innovationsfonden.dk/en/application/erhvervsphd

Impact on individual careers and labour market

New recruits, trained by the industry, are more likely to fit the needs of the firm if recruited by the same employer. On the other side, researchers and PhDs come with their knowledge and represent highly skilled and qualified personnel. This contributes to increasing the firms' absorptive capacity. Indeed, the evaluation reports provide data on the general employment situation of the PhD students, the sector in which they are employed, and compare their salaries to those of the PhD students that have not taken part in the scheme. Some of the reports analyse also the wider impact on the job market.

UK – Industrial Collaborative Awards in Science and Engineering (CASE) scheme[35]

UK's Industrial CASE scheme was introduced in 1994. The measure is opened to and used by several UK Research Councils.[36] In this report we examine the BBSRC's Industrial CASE. The research students spend part of their time with the partner company (between 3 and 18 months). Placements in industry are mainly in health research related companies, which makes the comparison with other countries/schemes, covering broader fields, complicated.

"The [UK's] Industrial CASE scheme [is considered to have] delivered highly skilled workers". Also, "the scheme has enabled industry to influence student training and this has helped ensure that the training meets the needs of industry and the wider UK economy."[37] Only 4% of the industrial CASE students are not employed (which does not differ from the average unemployment of PhD holders in the UK). Interestingly, the majority of the students obtained a post within the higher education sector and only a quarter of them in industry and commerce. Still, the share of students being employed by the industry is higher than for any other BBSRC scheme (see section on mobility and networking below).

The outcomes of the Danish Industrial PhD programme reveal similar level of employment among participants as in the UK Industrial CASE. Yet, a much larger share of beneficiaries than in the UK (ca. 80%) work subsequently in the private sector. What is more, the "Industrial PhDs earn approx. 7-10 percent higher wages than both regular PhDs and comparable university graduates". The study reports that 335 new jobs have been created as a result of the 50 Industrial PhD projects[38] included in the evaluation.

UK - Knowledge Transfer Partnerships (KTP)[39]

In the Knowledge Transfer Partnerships (KTP) a *"KBI* [Knowledge Based Institution] *promotes knowledge transfer between KBIs and businesses,* ***by placing a graduate or higher level associate in a business to undertake a specific research project****. KTP focuses on businesses needs, increasing their capacity to innovate and their competitiveness, thereby creating economic and wider social benefits. KTP also enables*

[35] http://www.bbsrc.ac.uk/skills/investing-doctoral-training/case-studentships/

[36] e.g. Medical Research Council, the Economic and Social Research Council, the National Engineering Research Council and the Science and Technology Facilities Council

[37] http://www.bbsrc.ac.uk/documents/1306-ind-case-evaluation-report-pdf/

[38] The public sector invested ca. DKK 70 million and the private DKK 170 million in 2006 for approximately 90 Industrial PhD projects (The Industrial PhD - An effective tool for innovation and knowledge sharing).

[39] http://ktp.innovateuk.org/

KBIs to find practical applications for the knowledge they create, therefore contributing to their capacity to carry out research and to teach."[40]

The evaluation of the UK's KTP scheme reports that between 5,550 and 6,010 net additional jobs were created by partnerships supported between 2001/02 and 2007/08. On average, each KTP partnership has created (or is expected to create) three jobs excluding that of the associate.

The evaluation of the French Cifre fellowships scheme focuses mainly on the professional future of the individual participants[41].

France - CIFRE (Conventions Industrielles de Formations par la Recherche) fellowships[42]

The CIFRE scheme dates back to 1981. The programme duration is similar to the one in Denmark – 3 years. The measure is financed by the Ministry for Higher Education and Research and is managed by the National Association for Research and Technology.

The CIFRE fellowships scheme reports that around 90% of the successful participants find a job within six months. What is interesting is that 46% of the respondents are employed thanks to the scheme directly in either the participating company (35%) or the university lab (11%). Around 2/3 of the CIFRE participants are employed in the private sector and around 25% in HEIs. 39% of the respondents confirm that their doctorate allowed them to make "significant jumps" (usually associated with an increase of salary) in their professional path. The salary levels of both groups are comparable with the ones of engineers – a profession receiving high wages in France and sought by the private companies[43].

Slovenia - Young researchers from the business sector

This measure was considered a build-up on the young researchers programme with the idea to provide PhD students with the opportunity to acquire practical experience. It was discontinued as a stand-alone policy initiative. The measure was evaluated as part of a bigger scope exercise assessing the schemes of the Ministry of Higher Education, Science and Technology, covering the period 2005-2007. The report is based on a survey among the different participants.

As a result of the training, almost 69 % of respondents remained employed in the same organisations in which they have been trained. Further to that, for 50% of the participants this was their first job. There is a specific aspect of the scheme which tackles the "brain-drain" issue and the report concludes that almost all the participants remained in Slovenia.

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40 http://webarchive.nationalarchives.gov.uk/20140827133341/http:/www.innovateuk.org/_assets/pdf/corporate-publications/ktp%20strategic%20review%20feb%202010.pdf

41 The report used is based on surveys of two cohorts of participants from 2000-2005 and 2006-2011 and whenever it was deemed suitable, a comparison was made between those groups

42 http://www.anrt.asso.fr/fr/espace_cifre/accueil.jsp#.VzscuObIaPw

43 It has to be noted this is a topic for discussion in France and the industrial PhD scheme is reported to perform better than the regular ones in terms of labour market insertion.

More at: https://www.ccomptes.fr/Accueil/Publications/Publications/L-insertion-professionnelle-des-jeunes-docteurs (Report of the Court of auditors on the professional prospects of PhD holders)

In fact, in some cases it is not easy to distinguish between different types of PhD schemes in a certain country. For example, compared to the level of unemployment among PhD holders in general, the data reported do not differ from the official statistics (Eurostat) – UK: 4% in 2009, 4.3% in 2011 and 3.9% in 2013; Denmark: 3.7% in 2009, 5.2% in 2011 and 4.6% in 2013 (levels 5-8 ISCED 2011).

However, all the evaluations suggest that the industrial PhD programmes have positive effect on employment through the new positions opened, lowering the levels of unemployment of the PhD graduates and shortening the periods between graduation and first job.

Among the notable achievements of this type of measures are better job prospects in terms of wages and faster career paths. What is more, some of the measures report the additional job creation effect.

We can therefore conclude that the industrial PhD programmes have a potentially positive impact on beneficiaries' career prospects and their employment.

Companies' **growth, additional funding and commercialisation**

The industrial PhD programmes do not only target students but also aim at strengthening the links between business and academia. Usually, identifying standard financial/economic impacts of "soft" measures is not an easy task. However, the evaluations report positive impacts on a series of outputs such as larger number of patents, increased exports and annual sales, bigger market shares. Some panels (e.g., UK's KTP) go even further in their findings and consider the return of investment to be very positive, value added and turnover grow faster for participating companies than the average firm in the economy as a whole.

Although based on limited data, the UK's industrial CASE scheme is reported to have triggered additional funding from the private sector partner to academics: "…36% and 41% of current and former academic supervisors, respectively, reported that they had obtained further funding from their CASE partner."[44] Another notable achievement, though limited in scope, is the commercialisation of research performed. As the report points out, "[a] small number of Industrial CASE studentships resulted in new intellectual property or the commercialisation of research findings. However, this was not common and it is important for BBSRC to manage industry partners' expectations in this area."[45]

In addition, the evaluation of the UK KTP reports that partnerships supported between 2001/02 and 2007/08 have created between £4.2 and £4.6 billion new sales for company partners and between £1.6 and £1.7 billion gross value added (GVA). "Return on investment is positive […] at £4.70 - £5.20 net additional GVA per £1 public money invested by sponsors". The largest average GVA impact and best return on investment is generated by partnerships with a medium sized company partner.

Interestingly, the panel evaluating the Danish Industrial PhD programme distinguishes between expectations and real outcomes. The section on economic effects is very telling: between 36 and 48 percent of the enterprises expect a larger number of patents, increased market shares, annual sales or exports. In comparison, after the end of the project, only 26.7 percent state that the project has led to/will lead to attainment of one or more patents. This discrepancy "may be due to the fact that the Industrial PhDs look at whether their project resulted in a patent from a narrower perspective, while the enterprise looks at this from a broader perspective in relation to the knowledge it has contributed to the enterprise"[46]. The large majority of the enterprises report increase in theoretical and practical knowledge. University supervisors acknowledge the progress in theoretical and practical skills; development of business-relevant knowledge at the

[44] http://www.bbsrc.ac.uk/documents/1306-ind-case-evaluation-report-pdf/
[45] Ibid
[46] http://ufm.dk/en/publications/2007/filer-2007/the-industrial-phd-programme-2007.pdf

universities through an Industrial PhD project; and insight into the research needs of the business world. "A very rough estimate shows an increased turnover of DKK 640 million, an increase in exports of DKK 150-200 million […]"[47].

Evaluators of the Slovenian "Young researchers from the business sector" scheme have found that companies which have benefited from the measure in comparison with the overall development of the economy as a whole enjoy 10 percent higher annual average growth rate of value added, 25 percent higher profit growth rate; 2 percent higher growth rate of net turnover.

Industrial PhD projects in Sweden[48]

The Swedish scheme is a longstanding policy initiative, but no evaluations have been identified. **The purpose of this measure is to promote knowledge flows between Swedish universities and the private sector by supporting doctoral projects in industry and commerce.**

The analysis of the Swedish industrial PhD projects is based on a research article examining three individual cases. Due to the limited coverage of this article one cannot draw general conclusions on the impact of this scheme. Nevertheless, the article reports that the industrial PhD programme participants acquire and transfer specific knowledge from one type of organisation to another.

It is clear that the assessments of the impact are very positive as regards to additional funding for universities and increased growth and sales of companies. In addition, the evaluations report on the enterprises increasing their theoretical and practical knowledge, academia developing a better perception of business-relevant knowledge at the universities and insight into the research needs of the business world.

Impact on mobility and networking

The evaluations report that the programmes also have longer term impacts on the intersectoral mobility of their beneficiaries. The mobility experience acquired during the PhD thesis enables the participants to create a network of contacts and the students can serve as intermediaries between public and private entities. Developing a professional network in industry and academia is reported as an important impact and prime motivation for participating in these schemes in the evaluations of CASE scheme, the Danish Industrial PhD programme and the Cifre programme. The latter evaluation tracks mobility patterns following defence of the PhD thesis and finds that, save from those employed in large firms, (intersectoral) job mobility remains high, especially that from the private sector to academia.

The CASE evaluation report finds the broadening of the professional network as one of the main drivers for PhD students to participate. Also the majority of the Cifre participants (64%) reported acquiring networking skills. In relation to their current employment, the beneficiaries confirmed the importance of the networking as a useful competence (75%).

The Danish Industrial PhD programme contributes to promoting collaboration and creating networks between universities and enterprises. In addition, Danish industry reports it enjoys broader contacts with partners and universities from abroad, which

[47] Ibid

[48] http://www.vr.se/inenglish/researchfunding/applyforgrants/callforproposals/closedgrants/industryphdproject.5.4b1cd22413cb479b8054185.html

could lead eventually to the internationalisation of their activities. Academics also confirm the measure helped in strengthening their business contacts.

The majority of the Cifre doctorates are employed in the private sector and 46% of them have remained in the company or the university lab that participated in the programme. Another 1/4 of the doctorate PhDs not directly engaged by any of the Cifre partners are recruited by another employer within three months and another 45% within six months. By linking these two indicators – time to get a job and change in the workplace, the evaluators conclude that the measure had a high mobility potential. According to the evaluation report, after eight years the number of Cifre PhDs employed in big enterprises has remained almost unchanged, while it has decreased in SMEs. The number of former Cifre participants working in HEIs or PROs increases over time, indicating mobility from the private to the public sector. The Cifre schemes note only a modest impact on international mobility, 85% of the total participants work in France.

To sum up, the policy measures had positive impact on mobility and networking activities among participants.

Drivers, barriers and recommendations

The evaluations of the British and Slovenian schemes point to the relatively heavy workload in industry, which is difficult to balance with academia expectations (publications of articles and thesis preparation). The UK KTP evaluation points that academics are less likely to get involved if the participation in the programme will not contribute to Research Assessment Exercise ratings[49]. The CASE evaluation reports a need to balance business side expectations towards the desired outcomes, since the primary focus is student training. The potential financial and at times heavy administrative burden can be a disincentive for (especially smaller) companies to participate in the respective schemes. In Slovenia and France the evaluations point out the relative lack of awareness of the needs of the company on the part of beneficiaries and their supervisors, whereas the evaluations of the Danish and Swedish schemes stress that it is important for the companies to be aware of the objectives of the scheme and to engage in advanced preparation. Previous contacts between academia and industrial partners are therefore important.

Conclusions

In terms of the impact on career perspectives and employment the industrial PhD programmes are reported to represent good "value for money" initiatives. A note of caution: the outcomes of these evaluations may not be specific to this type of measures, but could apply also to regular PhD programmes for which no benchmark is provided.

Participating candidates acquire new skills, practical experience and improved qualifications, thus increasing their chances on the labour market but also representing highly qualified personnel, which contributes to increasing the firms' "absorptive capacity". Several evaluations report a positive impact on a series of outputs such as larger number of patents, increased exports and annual sales, bigger market shares and additional R&D funding from the industry.

The potential in relation to the level of mobility that these measures create is significant: since the primary goal for this type of policy measures is to ensure an industry placement of PhD students while pursuing their doctoral studies in a university, intersectoral mobility represents a natural outcome of such schemes. Some evaluations also report longer term impacts on mobility.

[49] At the time of the KTP evaluation, the REFs predecessor the Research Assessment Exercise (RAE) was in place. The RAE (now REF) is a process undertaken on behalf of four UK higher education funding bodies which assesses the quality of UK research and informs the selective distribution of institutional research funding (Jonkers & Zacharewicz, 2016).

Moving back and forth between the public and private sector, the researchers create a network of contacts and serve themselves as intermediates between public and private entities.

Well-designed PhD projects, previous knowledge of the partner and the development of a research strategy by the firm are prerequisites for success of the policy measures. Other elements that should be taken into consideration are linked to IP regulation, workload and managing the expectations of the parties involved.

b. Building on Industrial PhDs - Industrial Postdocs

The programmes supporting the uptake of researchers in industry are different in nature compared to the measures analysed in the preceding section. In general they are designed to reduce the risk and costs involved in hiring a doctorate holder in a company.

We can distinguish among: funding for temporary employment of experts or post-doc researchers (e.g., loans of qualified personnel from academia) with a time span ranging from 3 months to 3 years; programmes addressing specific gaps in employment in industry, e.g,. female employment in industry or the humanities, and employment of social science researchers via different means (typically financing 1-3 years placements).

Additionally, we analyse the French R&D tax credits covering researchers' salaries, which help the companies to absorb the qualified workforce and, in this way, have an indirect effect on the intersectoral mobility.

Country	Type of the scheme	Title of the evaluation
Austria	Female students placements in industry	FEMtech evaluation (part on Career Paths) 2011
Poland	Short placements of academics/business researchers from SMEs	Tekla + - the capital of placements. Evaluation report 2015 (regional scheme)[50]
Sweden	SSH postdoctoral researchers placements in industry	Flexit programme progress report 2013[51]
France	R&D tax credits	Développement et impact du crédit d'impôt recherche : 1983-2011 (Evaluation, 2014)[52]
Canada	Industrial fellowships for recent PhD graduates	Evaluation of NSERC's Industrial R&D Fellowships (IRDF)[53]

[50] http://docplayer.pl/10749085-Vi-edycja-tekla-plus-stolica-stazy.html
[51] http://www.rj.se/globalassets/engelska-sidan/progress-reports/flexit-progress-report.pdf
[52] http://www.ladocumentationfrancaise.fr/var/storage/rapports-publics/144000685.pdf
[53] http://www.nserc-crsng.gc.ca/_doc/Reports-Rapports/Evaluations/IRDFReport2013_e.pdf

Building on results of Industrial PhDs - Industrial Fellowships

The evaluation of the Canadian scheme – Industrial R&D Fellowships (IRDF) –shows that nearly all IRDF recipients were working full-time after the period of the fellowship and the vast majority of them identified research and development as their primary work activity. Almost half of the recipients were subsequently offered a job in the hosting organization.

Canada - Industrial R&D Fellowships - Natural Sciences and Engineering Research Council of Canada

The Industrial R&D Fellowships were established in 1980 to provide financial contributions that support the most promising recent doctoral graduates to engage in research and development in the private sector and with not for-profit and non-governmental organizations. By minimizing the cost for companies to hire a talented PhD graduate for a two-year period, these fellowships promote the development of industrial research capacity (especially in small- and medium-sized companies). Furthermore, the IRDF allows companies to consider a fellow for potential long-term employment with reduced risk. The programme was discontinued in 2014 as the support was taken over by MITACS[54] - the single delivery agent of federal support for postdoctoral industrial R&D fellowships.

Short placements – building awareness and trust

In Poland several projects funded from the regional structural funds facilitated the temporary employment of scientists by companies, with the largest example being TEKLA+. In the period 2013-2015 this scheme had supported altogether 115 science-industry collaborations through six months placement of researchers in SMEs and SMEs researchers in academia (2013-2015). The qualitative evaluation showes the general high satisfaction of the beneficiaries with the scheme (both companies and researchers) but does not provide any data on the impact of the scheme on companies' competitiveness and innovativeness. The programme was seen as one of the means to raise awareness in industry of the potential of academia-industry cooperation as well as to build trust among the actors. The short six-month time spent on exchange indeed does not presume yielding significant tangible results such as preparing and co-authoring a scientific publication or a patent. At least the evaluation does not report on quantitative outcomes.

POLAND – REGIONAL STRUCTURAL FUNDS – TEKLA+

Short six-month placement of business researchers in academia and academic researchers in industry (SMEs). In 2013-2015, the programme financed 115 placements in Mazovia. TEKLA+ was financed from the regional structural funds.

Addressing specific gaps in employment of researchers - pilot programmes

[54] MITACS stands for Mathematics of Information Technology and Complex Systems. It is a national, not-for-profit organization that has designed and delivered research and training programs in Canada

Austria - FEMtech Career Paths - the Austrian Federal Ministry for Transport, Innovation and Technology

FEMtech is a programme of the Austrian Federal Ministry for Transport, Innovation and Technology (Bundesministerium für Verkehr, Innovation und Technologie – BMVIT) initiated in 2004 to promote women and to secure equal opportunities in research and technology. FEMtech Career Paths aims at improving the career opportunities for (potential) entrants in companies and organisations of industrial and non-university research. The intention is to boost the attractiveness of technical and science related professions for women in order to increase the total number of highly qualified women.

Sweden – FLEXIT - Riksbankens Jubileumsfond

Set up in 2009 by Riksbankens Jubileumsfond (RJ), Flexit is a pilot postdoctoral programme that seeks to improve contacts between higher education institutions (HEIs) and the business sector on a trial basis. It targets humanities and social science postdoctoral researchers and offers placements up to three years in the business sector. These placements are composed of 75% research and 25% service in a company with the fund financing the research-related salary costs and other expenses.

The examples of highly specific programmes (FEMtech and Flexit) are very difficult to evaluate - they are small and the effects of the interventions are therefore also limited. As the FEMtech evaluation shows, the programmes demand considerable efforts with unknown impact on the actual career paths of the targeted group. Besides, several approaches and methods are applied at the same time – industrial PhD and Master thesis, coaching, mentoring, training and awareness raising. In total the measure has reached 140 female students with the average support of €15.000. Those programmes are also characterised by low interest from industry and the push comes rather from the higher education side that secures the funding and identifies companies interested in the placements rather than the other way round.

Failure cases

The analysis of the Member States schemes shows that in some countries the schemes were introduced but shortly afterwards closed due to the lack of interest from industry (e.g. Poland, Lithuania and Sweden).This does not mean that the schemes do not work as such, but probably they demand a different design to attract companies. For example, the Polish KadTech programme, co-funding salaries of scientists temporarily employed by business enterprises and delegated by public research organisations or higher education institutes to carry out R&D projects, was not popular among applicants: only two companies were awarded the support, and the programme was soon discontinued. One of the explanations might be the hidden costs for the company.

The evaluation of the Swedish Flexit programme[55], where the company provides a mentor for the researcher, shows that the business side had to cover additional costs from the time spent on writing an application form to the time when the senior staff is allocated to the mentorship. The sometimes unclear expectations from the project or the difficulties in motivating the researchers are additional factors that drew back industry from more active participation in the Flexit programme.

Another way of supporting intersectoral mobility – the French case study

[55] Swedish Research Council abandoned the scheme due to lack of interest in 2014. More at: http://vr.se/franvetenskapsradet/nyheter/nyhetsarkiv/nyheter2013/nyheter2013/ingennyutlysningavindustridoktorandprojekt.5.7e727b6e141e9ed702b15e5.html

The evaluations of the French tax credit (CIR) shows that 49% of R&D costs, which qualified for the tax credit in France, are researchers' salaries, while only 12% qualified as external research. The tax credit is therefore one of the main policy instruments to support the absorption of a qualified work force in French industry[56].

France - CREDIT IMPOT RECHERCHE

The French tax credit regime was implemented in 1983 but revamped in 2008 to become entirely volume based. France's research tax credit covers 30% of all R&D expenses up to €100 million, and 5% above this threshold. Salaries for research staff are wholly integrated, plus 50% of R&D operating costs and 75% of investments in R&D operations.

The evaluation of the French R&D scheme shows that the combination of schemes (in this case the Industrial Doctorate - CIFRE with the tax credit) has the highest potential. The tax credit can be used to complement the funding of the industrial PhD or to employ the CIFRE recipient after his/her thesis is finalised. That means that those measures are complementary.

In France the policy mix is designed to support the highly qualified business R&D workforce and therefore there are little restrictions on combining the direct and indirect funding support. The evaluation report explores the possible synergies between the R&D tax credit and even goes further in giving concrete examples on how to cumulate different financing sources.[57]

Conclusions

- In all long term placements the recipients are directly employed in the company and only the research-related part from the salaty of the employee is reimbursed. This creates a stronger relation between the researcher and the company.
- Short placements may increase awareness of companies of knowledge and technology transfer activities and build trust between the actors based on personal relationships but the evaluations do not point to significant tangible results such as increased patenting activities or co-publications (see also Edler et al. (2011)
- Longer post-doctoral placements create a personal relation with the company and often result in the prolonged collaboration of the sectors and/or in the offer of a permanent employment in the host company.
- Programmes targeting specific groups (e.g. women, SSH researchers) are mostly pilots (for now) and too limited in scope to yield sufficient impact and thus difficult to measure.
- Main barriers include the lack of awareness of industry, unclear expectations from the programmes for the business, high administrative burden linked to the application as well as additional costs for the hosting company (financial participation but also human resources devoted to mentoring).
- Combination between different instruments could create synergies and this is an avenue worth exploring in order to achieve a systemic change.

[56] According to the conditions necessary to receive the CIR, salaries are indeed accounted as R&D expenses (see the following doc, p.6 in the box: http://www.impots.gouv.fr/portal/deploiement/p1/fichedescriptive_6914/fichedescriptive_6914.pdf

[57] Développement et impact du crédit d'impôt recherche: 1983-2011 (p. 60)

c. Academic entrepreneurship and spin-offs

A special case of intersectoral mobility is the creation of spin-offs by academic staff that exploit research outcomes. It is difficult to confine this new business creation to a strict definition, as spin-offs vary depending on the origin and the objectives of the entrepreneurs, their relations with the public sector research, as well as on the firms' output (Mustar 2002). According to Mustar et al. (2006), one of the streams of literature takes a resource-based perspective to spin-offs. Within that perspective, the category of human resources directly relates to the issue of intersectoral mobility as it refers to the attributes of the personnel of the company. Usually, human resources are measured as size of the founding team, background of the founders, professional management experience, and organisational size (Mustar et al. 2006).

A commonly accepted justification for the support of spin-offs is "that economic growth depends strongly on the development of technology transfer between public research and industry, especially through the creation of new knowledge-based firms" (Mustar 2002). In addition to that the creation of companies can improve the image of the public research organisations and can increase their possibilities to attract skilled young researchers. (Mustar 2002)

According to Clarysse et al. (2007), during the 1990s many universities in Europe had financing difficulties and were seeking additional sources of income. Policy makers also considered universities to be a part of the innovation process and introduced changes in the legislation as well as policy measures for supporting young companies. The policy instruments aim at increasing the number of academic spin-offs, enhancing their quality and their likelihood to succeed.

Mustar (2002) defines six main groups of public policies that support spin-offs from higher education and research organisations: researchers' status, intellectual property, training in entrepreneurship, competitions, incubators and seed capital. The policy measures related to the researchers' status are especially relevant to the intersectoral mobility issue. A policy framework has to be in place in a given country, which allows the academic staff to participate in the creation and development of private enterprises. Training programmes on entrepreneurship are a wide-spread instrument for enhancing the mobility of researchers between the scientific and the industrial sector.

Although policies supporting the creation of spin-offs are in place in the member states, we could find just a small number of evaluations of those measures.

Austria – AplusB (Academia plus Business)[58]

Launched in 2002, the AplusB programme supports innovative, technology-oriented spin-offs from the academic sector in Austria. The programme funds the so-called AplusB centres that provide professional support for scientists in the process of turning a good idea into a viable business. The centres were initiated by the Austrian Federal Minister of Transport, Innovation and Technology (bmvit), and the Austrian Research Promotion Agency (FFG).

The programme AplusB is evaluated in Tangemann et al (2010). In the report, all AplusB supported start-ups from July 2002 to December 2009 are analysed on the basis of 1943 questionnaires. The analysis covers the pre-incubation, incubation and early stage phases of the companies development.

According to the report, the AplusB objective of ensuring an increase in the number of academic spin-offs has been achieved. It is also indicated that the likelihood of success was increased and the reported survival rate is 96% for the covered period. At the time

[58] https://www.ffg.at/en/aplusb-academia-plus-business

when the evaluation was performed, the average age of the newly created firms was 2.5 years. The total number of the created jobs was 1323 (full time equivalents), 72 % of which were held by staff having university degrees. The firms were relatively small: one quarter of them had six and more employees, and only 10% - more than 11 employees. As for the average annual growth rates, two thirds of the newly created firms grow, 13% annually double the number of their employees. 29% of the firms stagnate and 5% reduce the number of employees. The maximum average annual growth rate with 95% is observed in the first business year. It decreases to 31% in the second, 28% in the third, and to 13 % in the fourth business year. The distribution of the average annual growth rate of turnover is as follows: 86% of the firms have a positive average annual growth rate, 13% have zero growth, and 11% have a negative growth rate. Companies that increase their turnover do not necessarily increase the number of employees. AplusB start-ups are characterized by a high degree of knowledge input and higher growth rates compared to newly created companies in R&D intensive sectors in Austria in general (Egeln et al., 2007 in Tangeman, 2010).

The biggest barrier to the companies is funding in the early stage as venture capital is limited. Public funding is very important for the majority of the new companies (Tangeman, 2010).

Germany - EXIST (University-based business start-ups)[59]

Launched in December 1997, EXIST is a support programme of the German Federal Ministry for Economic Affairs and Energy (BMWi). The key objectives of the programme are to establish a culture of entrepreneurship in university teaching, research and management for the long term; consistently translate the findings of academic research into economic value; significantly increase the number of innovative business start-ups and create secure new jobs in the process.

The long lasting EXIST programme has undergone a number of changes in its development. At the beginning the programme supported exclusively institutions and only indirectly supported individuals and companies. In March 2000, a funding line for individuals was introduced in the form of "EXIST-SEED" (a broad approach, replaced by the EXIST "Business Start-up Grant" programme in 2007) and another such scheme was introduced in May 2007 in the form of the "EXIST Transfer of Research" programme (an approach based on excellence). (Kulicke, 2014)

The EXIST programme currently consists of three funding lines, which form its core:

(1) **EXIST Culture of Entrepreneurship** supports universities in formulating and implementing a comprehensive and sustained university-wide strategy for increasing entrepreneurial culture and spirit.

(2) **EXIST Business Start-up Grants** supports students, graduates and scientists in preparing innovative technology and knowledge based start-up projects.

(3) **EXIST Transfer of Research** funds both the resource development necessary to prove the technical feasibility of start-up ideas based on research and the preparation necessary to launch a business.

The development of the EXIST funding programme between 1998 and 2013 has been evaluated in several reports: Kulicke (2006), Becker et al. (2011), Kulicke and Kripp (2013), Kulicke (2014).

[59] http://www.exist.de/EN/Home/home_node.html

During the long lasting development of the programme, there have been a lot of initiatives with different priorities, funding models and incentives schemes. Some quantitative data excerpted from the evaluation reports can give a notion of the impact of the EXIST programme.

The initial programme period 1998-2005 is assessed in Kulicke (2006), which is a predominantly qualitative evaluation. The report stresses the pioneering character of the EXIST programme that managed to introduce the concept of academic start-ups into the university culture. Much of the programme at this early stage was focused on creating the right framework conditions for academic entrepreneurship. Its main focus was not to financially support researchers in their individual start-up projects. However, EXIST-SEED (the predecessor to the EXIST line of funding evaluated in Kulicke and Kripp (2013)), which does directly financially supports spin-offs, already existed.

Initially, there were just five EXIST model-initiatives. EXIST SEED funding was available from 2000. In 2002, the scope of the whole EXIST programme was extended to ten additional transfer initiatives. EXIST-SEED funding for the transfer initiatives was available from 2004. In 2005 EXIST-SEED funding became available nationwide. (Kulicke, 2006)

Until 2004, the total number of spin-offs in the model-initiatives was 1031, i.e., 40% of all "supervised" (not necessarily funded) initiatives. By 2005, the total number of spin-offs in transfer-initiatives was 926, i.e., 26% of all "supervised" initiatives. At least 10-16% of the supported spin-offs failed. The size of the spin-offs created within the model-initiatives is limited. In 2004, 3-4 employees were recruited on average in addition to the founders. The total number of employees in the supported companies was approximately 3000. In 2005, within the model-initiatives, no additional employees were hired. The total number of employees in the newly created firms was approximately 1100. As for the gender balance of the applicants for the grants, 88% of the total number of applicants were male, and 12 % female. (Kulicke, 2006)

Overall, the evaluation sees the early EXIST programme as a success in so far as awareness raising and creation of framework conditions are concerned. As regards the actual creation of spin-offs, it is more critical, namely:

"The number of start-ups that served explicitly the transfer of scientific research results into economic value added remained significantly below expectations. Start-ups in the context of EXIST did result in a person-bound transfer of technology, but only in few cases in the form and intensity as it is intended by Key Objective 2 (Consistent translation of scientific research results into economic value). The planned realignment of EXIST should therefore - as recommended by Kienbaum (2005) – put a higher weight on measures, which are explicitly tailored to the target group of the academic staff and cover the whole process from the development of business ideas to the exploitation of scientific research results." (Kulicke, 2006)

The study carried out in 2011 (Becker et al., 2011) considers the line of funding Transfer of Research (Forschungstransfer - EFT in addition to Business Start-up Grant (Gründerstipendium -EGS). The difference between the two lines of funding is that the former is exclusively focused on excellent, complex and high risk spin-off projects, whereas the latter is more general. Within the Gründerstipendium, at the time of the survey, 60.3% of the funded projects resulted in a spin-off that still existed, 31% were still considering to set up a spin-off, 5% definitely gave up, and 4% founded a spin-off that failed. Within the Forschungstransfer, at the time of the survey, 54.2% of the funded projects resulted in a spin-off that still existed, 43% were still considering to establish a spin-off, and 2% definitely gave up.

The survival rate of the spin-offs after two years is as follows: within Gründerstipendium, 90% out of the 78 spin-offs that responded to the survey, and within Forschungstransfer, 100% out of the 9 spin-offs that responded to the survey. (Becker et al., 2011)

As far as the patent creation is concerned, 32.9% of the spin-offs registered patents within the Gründerstipendium, and 43.3% within the Forschungstransfer. (Becker et al., 2011)

In terms of employment, 40.5% of the spin-offs hired employees (4.9 persons hired on average) within the Gründerstipendium, and 46.7% (2.8 persons on average) – within the Forschungstransfer. (Becker et al., 2011)

Further funding was received as follows: within Gründerstipendium, 17.7% of the spin-offs secured additional private funding (on average 700 000 €) and 32.9% applied for further public funding; within Forschungstransfer, 23.3% secured additional private funding (on average 440 000 €) and 43.3% applied for further public funding. (Becker et al., 2011)

The evaluation carried out in 2013 (Kulicke and Kripp, 2013) reports that 752 spin-off projects received funding between 2007 and 2011. The results of the projects are as follows:

- realisation rate (i.e., after one year funding period the spin-off was realised/founded and became commercially active): 78%;
- failure rate (no spin-off was founded): 16%
- survival rate (i.e., the spin-off was still existing and commercially active in 2013): 65% of the funded projects, while out of the actually realised spin-offs 85% survived. (Kulicke and Kripp, 2013).

In 2013, the average of the employees in the spin-offs was 6.5 (median of 2). The estimated total number of employees in 2013 for all still existing spin-offs out of the founded 752 is 3000. In 2012, the turnover of the spin-offs was between 10 and 50 million euro for the top 1%, and over 0.5 million euro for 85%. In 2013 the R&D intensity of the spin-offs was quite high: 54% of the spin-offs invested more than 20% of their turnover in R&D. The most important modes of financing were own financial resources for 60% of the firms, realised profits for 65%, public funding for 52% and equity financing for 29%. Within the equity financing, business angels or other private persons were the most important sources for 72% of the firms.

Belgium - FIRST Spin-off ("Formation et Impulsion à la Recherche Scientifique et Technologique" (Training and Promotion of Scientific and Technological Research)

Launched in 1999, the FIRST Spin-off programme supports projects aiming at the development of a new product, process or service, and the undertaking of a technical-market feasibility study for the exploitation of the results and a business plan over five years with the general view of launching a spin-off in the Walloon Region. The projects must be achievable in two years with a possible extension of one year.

Table 4 below provides the number of grants awarded, as well as the budget (in thousands of euros) allocated per year within the FIRST Spin-off programme.

Table 4. Number of grants awarded and budget (in thousands of euros) allocated within FIRST Spin-off

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of grants	15	17	13	17	12	12	10	13	13
Budget	3386	5240	4191	5888	3880	4476	3187	3018	3046

Source: Evaluation de la politique scientifique de la Wallonie et de la Fédération Wallonie-Bruxelles 2012-2013, Conseil Wallon de la politique scientifique (CPS)[60]

[60] http://www.cesw.be/index.php?mact=publications,cntnt01,default,0&cntnt01what=publication&cntnt01alias=Rapport-du-CPS&cntnt01returnid=57&a=view

Between 1999 and 2012, 182 grants have been awarded out of 292 applications under FIRST Spin-off.[61] According to the evaluation of the Conseil economique et social de Wallonie (CESW) of the scientific policy of the region 2010-2011, more than 50 spin-offs have been created over this period.[62]

According to the recommendation of the Walloon Science Policy Council on the public support awarded to spin-offs in Wallonia (2011)[63], the following factors may explain why this rate is not higher:

(1) The researcher does not always have the required entrepreneurial and managerial skills.

(2) The prospects of economic exploitation of the research results is sometimes taken into account too late.

(3) The negotiation with the parent institution to award the project owner a license for the exclusive and free use of research results during the first years of the spin-off also appears too late in some cases.

Some adjustments have been implemented to the scheme, which aim at ensuring the quality of the supported projects and fostering the economic exploitation of the research results:

(1) The funding is dependent on the prior identification of the prospects of the potential economic exploitation of the research results via a spin-off;

(2) The funding is extended by one year and gives the possibility to hire a "business developer" responsible for the economic exploitation of the research results.[64]

Conclusions

The policy instruments related to spin-offs are focused on increasing the entrepreneurial potential of research organisations through training and professional support to scientists in the exploitation of research results. Support is extended mainly to the pre-incubation, incubation and the early development phase of the business venture in order to raise the likelihood of success. Most businesses stemming from public sector research remain small.

The policy measures have had the following impact:

- establishing a culture of entrepreneurship in university teaching, research and management;
- developing the potential for business ideas at universities and research institutions in a targeted manner;
- promoting the translation of research findings into economic value;
- increasing the number of innovative business enterprises and creating new jobs, although in general the spin-offs remain small.

The policy measures targeting academic entrepreneurship are an important component of the innovation systems.

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[61] Source: DG Growth, Regional Innovation Monitor, https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/first-spin

[62] Ibid

[63] Ibid

[64] Ibid

Evaluation methods

Table 5 summarises the methodologies used in all the evaluations analysed in this report. Only 3 evaluations out of 13 used a control group to control for the effects of the interventions, including one case where the results were not robust enough to allow for comparison. None of those control groups were used for a full-fledged counterfactual analysis but they do still give some perspective on the additionality of the outputs of the policy measure.

Most of the evaluations use a triangulation of quantitative and qualitative methods, mainly surveys, programme monitoring data and interviews with beneficiaries, project managers and other stakeholders.

Only rarely, the evaluations analysed were conducted with a sufficient time lag to be able to study also the longer term outputs and impacts. Most of the measures were evaluated just after the end of the treatment and therefore could only capture the immediate outcomes of the measure and often concentrated on beneficiaries satisfaction and perceived future changes of behaviour as declared by participants.

The Industrial PhD programme in Denmark, the CIFRE fellowships in France, Industrial CASE in the UK, Aplus B in Austria and the EXIST programme in Germany can be used as good practice examples, given the frequency of evaluations and the relative sophistication of the evaluation methods used. We should however mention that those programmes have been in place for many years and therefore allowed for a more systematic approach to their evaluation, whereas in many countries the programmes are relatively new. Yet, the examples above provide a good opportunity for policy learning.

Table 5. Evaluation methods used in the evaluations analysed in the study

Evaluation	Survey	Programme monitoring data	Interviews	Focus groups	Case studies	Control group	Other methods	Timeline
Industrial PhD Programme DK	X	X				X Comparison between employment rates of beneficiaries and other PhD holders	Based on previous evaluation data	Policy measure runs since 1970 (with revamps based on evaluations)
CIFRE fellowships FR	X							2000-2001 cohort
Young researchers in the business sector SI	X	X	X	X				
Industrial PhD projects SE					x			
Industrial CASE UK	X	X					Expert Panel review of data	Different timeline for different data but core data related to 2004-2010. Evaluation carried out in 2012 with data gathered in 2011.

Evaluation	Survey	Programme monitoring data	Interviews	Focus groups	Case studies	Control group	Other methods	Timeline
Knowledge Transfer Partnerships UK	x	x	x					
Industrial fellowships for recent PhD graduates CA	x	x	x		x	x Low response rate from unfunded applicants (data not used)		Assessment of immediate and intermediate impact, analysis of 2000-2011 programmes run in 2012.
Femtech Career Paths AT (part of larger evaluation of Femtech programme)	x	x	x				Outreach analysis Self-assessment (implementation body)	Assessment of medium-term effects and impact – 2-3 years since the set-up of the policy measure.
FLEXIT SE (Progress report)	x	x	x					Assessment of progress – 4 years since the setup of the policy measure
Tekla + PL	x	x	x					Assessment of short term effects – maximum a year after the placement took place
AplusB AT	x	x				X (questionnaire)	Use of national	2002-2009

Evaluation	Survey	Programme monitoring data	Interviews	Focus groups	Case studies	Control group	Other methods	Timeline
							statistics Evaluations of policy measures in other countries as benchmark	
EXIST DE	x	x					Use of national statistics	2007-2011 programme evaluation carried out in 2013
FIRST Spin-off BE							Use of national statistics	1999-2011 time period, evaluation carried out in 2011

7 Conclusions

Policies to foster intersectoral mobility are in place in almost all MS. Many of them have been implemented for several years now, yet readily available evaluations are scarce.

The reasons for such a limited availability vary – publication issues (the evaluations are considered "for internal use only"), lack of systematic evaluations or schemes are not evaluated at all. In addition, language restrictions (evaluations available only in national language) would necessitate an investment of considerable resources to build a comprehensive collection and analysis of documents.

The limited evaluation culture also has an impact on the quality of the evaluations. Some evaluations seek to prove that the scheme works and report on largely positive outcomes and effects (as initially designed and laid down in the programmes). As a result of this, some of them measure only direct outputs of the schemes, coming short of evaluating their broader socio-economic impact. Counterfactual evaluations are very rare (for an exception see: Herrera et al, 2010).

Given that quite a number of measures have been discontinued, it would be very valuable to analyse the failure cases but so far they have been not (openly) discussed.

All the reasons above restrict the possibility to evaluate the impact of intersectoral mobility policies, which would allow for greater policy learning.

Yet, in the small sample of the evaluations we have analysed, the evaluations provide proof of positive impact of those measures on researchers' skills and employability. To a lesser extent data are provided also about patent and publications propensity and R&D intensity of companies.

The strongest evidence is provided in the industrial PhD programme evaluations where the impact on skills and employability of PhD researchers can be clearly attested.

The analysis of the policies supporting spin-offs provides evidence that they increase the entrepreneurial capacity of research organisations and promote the translation of research results into economic value.

The policy measures build also industry awareness of knowledge transfer, increase the absorptive capacity of firms for internal and external R&D, strengthen academia – industry collaboration and build trust between actors.

The main barriers to the success of the schemes relate to the unclear benefits to participating firms., which further strengthens the case for good impact evaluations, administrative burden on companies as well as the additional workload linked to integrating new people into the company.

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Annex 1

Indicators on Knowledge Transfer and Intersectoral mobility

The purpose of this annex is to give an overview of how the countries perform in selected, widely acknowledged knowledge transfer indicators. We conduct the analysis on the basis of available indicators, which allow the widest comparison between all countries covered in this paper. While we acknowledge the fact that a mere quantification of KT activities may lead to a biased assessment of a KT system's effectiveness, we do believe it is important to give a more general picture of the countries' performance.

The annex provides information on the following indicators:

- Mobility patterns of researchers (MORE2);
- Researchers (PhDs) employed by business (BES) sector (Eurostat);
- Public-private co-publications (Scopus);
- Innovative firms cooperation patterns (CIS, Eurostat);
- Publicly performed R&D financed by the business (Eurostat).

On the next few pages we will provide justification of our selection of indicators and depict the performance of the countries (EU28 Member States and Associated Countries).

Mobility patterns of researchers (MORE2)

For the mobility patterns of researchers we use as data source the MORE 2 Study[65] to reveal patterns for the intersectoral mobility patterns across Member States. Two indicators are of particular interest for this study: 1) intersectoral mobility during PhD and 2) intersectoral mobility in post-PhD career. Both indicators take into account only researchers currently working in the academic sector, who have experience subject to a more than 3-month intersectoral mobility period to one or several destination sectors. The modalities of the two indicators are defined as follows:

- **Work placement or internship during PhD** related intersectoral mobility groups all the sectors different from academiathe academics into a "non-academic sector". This makes the data more difficult to interpret thus complex to use. The indicator covers percentage of: R1 PhD candidates and R2 (post-doctoral researchers or(or equivalent).
- As far as **post-PhD intersectoral mobility** is concerned, there is data broken down by public/ government sector, private not-for-profit sector and private industry. The indicator covers the percentage of: R1 PhD candidates and R2 (post-doctoral or equivalent) PhD holders and post-PhD only for R2 (post-doctoral researchers (or equivalent), R3 (established researchers) or R4 (leading) researchers. Multiple destination sectors per respondent are possible.

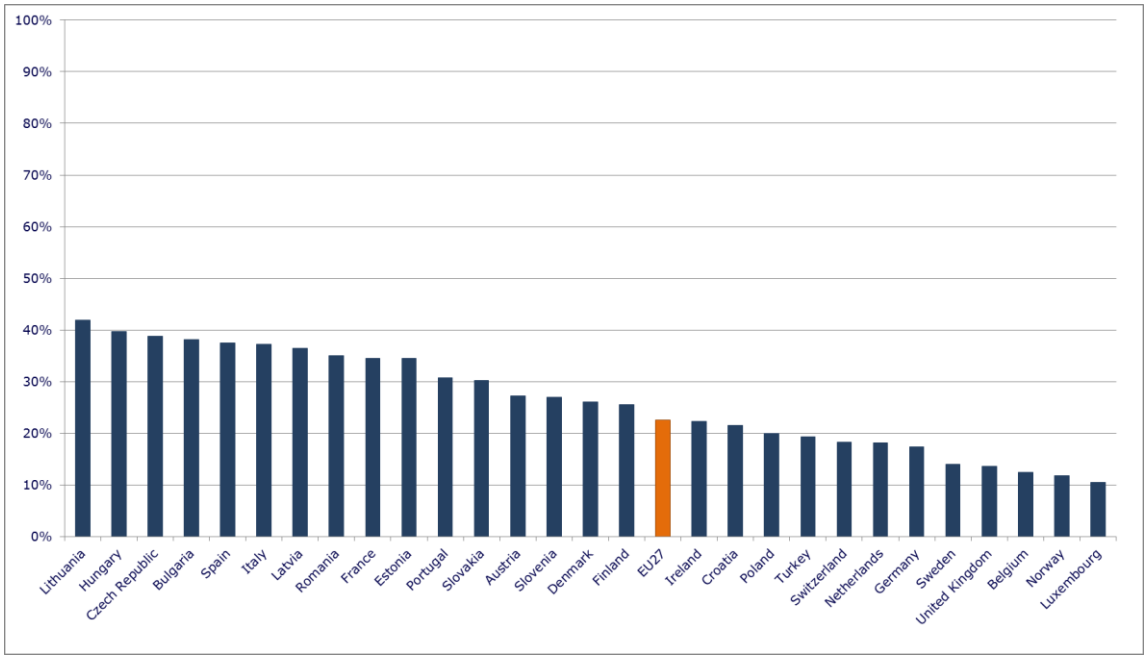

Figure 6 Work placement or internship in the non-academic sector during PhD (per country of PhD)

Data: MORE2 HEI survey (2012)
Report: IDEA Consult et al, 2013. MORE2 - Support for continued data collection and analysis concerning mobility patterns and career paths of researchers, HEI report (WP1). European Commission, DG Research and Innovation.

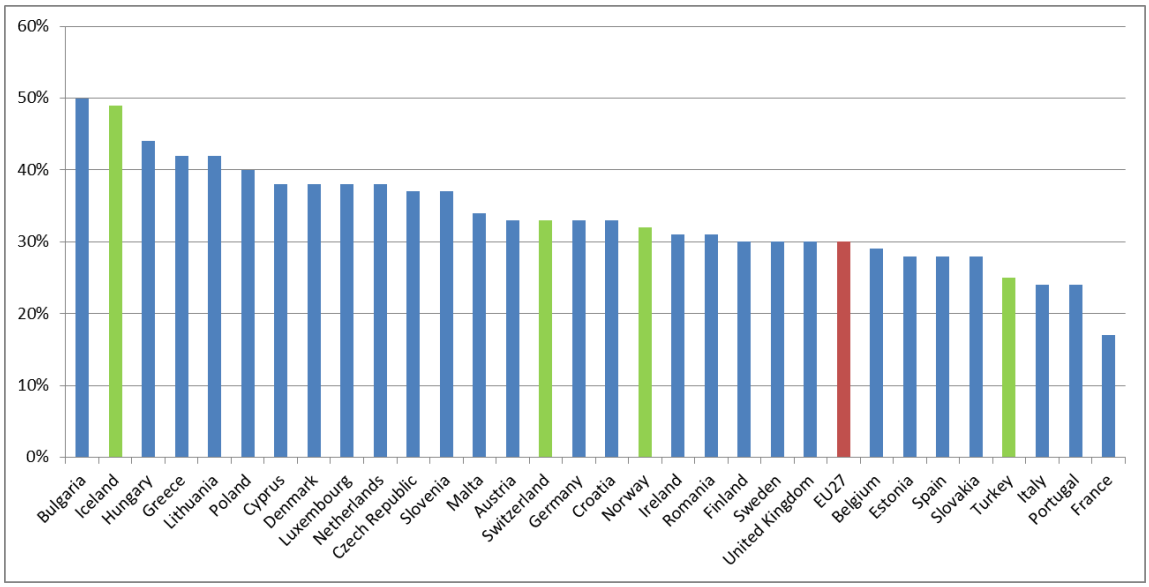

Figure 7 Intersectoral mobility per country. Survey of doctorate holders currently employed in the Member States universities that have spend more than 3 months in industry.

Data: MORE2 HEI survey (2012)
Report: IDEA Consult et al, 2013. MORE2 - Support for continued data collection and analysis concerning mobility patterns and career paths of researchers, HEI report (WP1). European Commission, DG Research and Innovation.

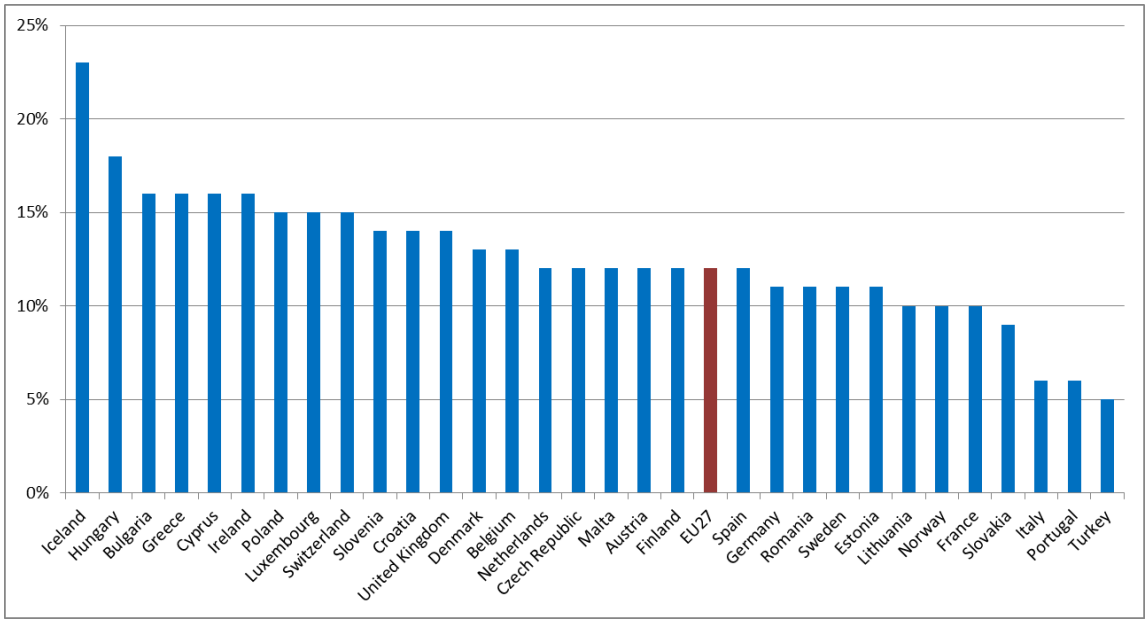

Figure 8 Intersectoral mobility to private industry (per country)

Data: MORE2 HEI survey (2012)
Report: IDEA Consult et al, 2013. MORE2 - Support for continued data collection and analysis concerning mobility patterns and career paths of researchers, HEI report (WP1). European Commission, DG Research and Innovation.

Researchers (PhDs) employed by BES (Eurostat)

The number of doctorate holder by sector of employment is a relevant indicator for this report. Unfortunately, a full coverage of all Member States is not feasible given data scarcity. In fact, the only source which provides harmonised information on this topic is the OECD/UNESCO Institute for Statistics/Eurostat Careers of Doctorate Holders (CDH) project. However, oIn fact, only half of the EU Member States (14: BE, BG, DK, ES, HR, HU, LT, LV, MT, NL, PL, PT, RO and SI) are covered by the CDH project. To overcome this shortcoming, we use a similar indicator instead, i.e. number of researchers by sector of performance and as percentage of the total employment. We consider this a reasonable proxy based on the following definition: "***Researchers*** *are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned*" (OECD Frascati Manual, 2002). In addition, several studies acknowledge that the employment of university researchers is an effective way to transfer knowledge from universities to firms (Zucker et al., 2002; Gübeli and Doloreux, 2005). A reasonable assumption is that many of the researchers either have already received their doctorate or are involved in R&D activities in order to obtain a PhD. In any case, this indicator is linked to ISM, because researchers are initially trained in academia and then they move to other sectors (see supra) and also their presence in the firm unveils the absorptive capacity of the company. Last but not least, this indicator allows cross-country comparison at EU level.

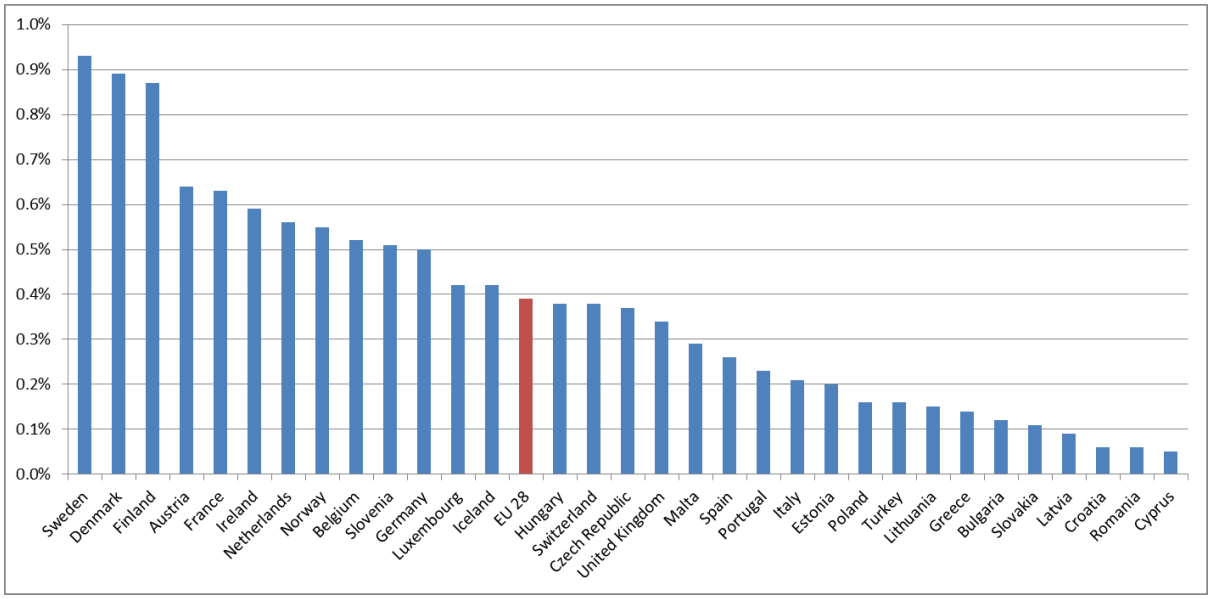

Figure 9 Countries according to the number of researchers employed in industry as share of total employment (Eurostat, 2016)

Public-private co-publications

Public-private co-publications,scientific publications co-authored by both researchers from academia and industry, are considered as one of the ways to measure university-industry interactions (Calvert and Patel, 2003), a proxy of the collaborations between both (Tijssen et al., 2012) or one of the co-authorship-based indicators relevant to knowledge transfer (Abramo et al., 2009). The indicator does have certain drawbacks. It covers only one aspect of co-authorship activities between industry and academia (scientific papers) and leaves out other forms of collaboration (e.g. patenting); the data is rather stable over time and is slow to react immediately to changes in policies. Despite the limitations described, the indicator is a useful, if partial, indicator of public private collaboration / knowledge transfer.

For the purpose of the analysis, the indicator is elaborated on the basis of Scival (based on Scopus data). The indicator is described as the number and/or percentage of scholarly outputs that have been co-authored by researchers from both academic and corporate, or industrial, affiliations. We provide the 2003-2014 overall score (in percentage) of academia-industry co-publications by country and field as well as the number of public-private co-publications per thousand of researchers (FTE) of population for 2014 (or latest year available).

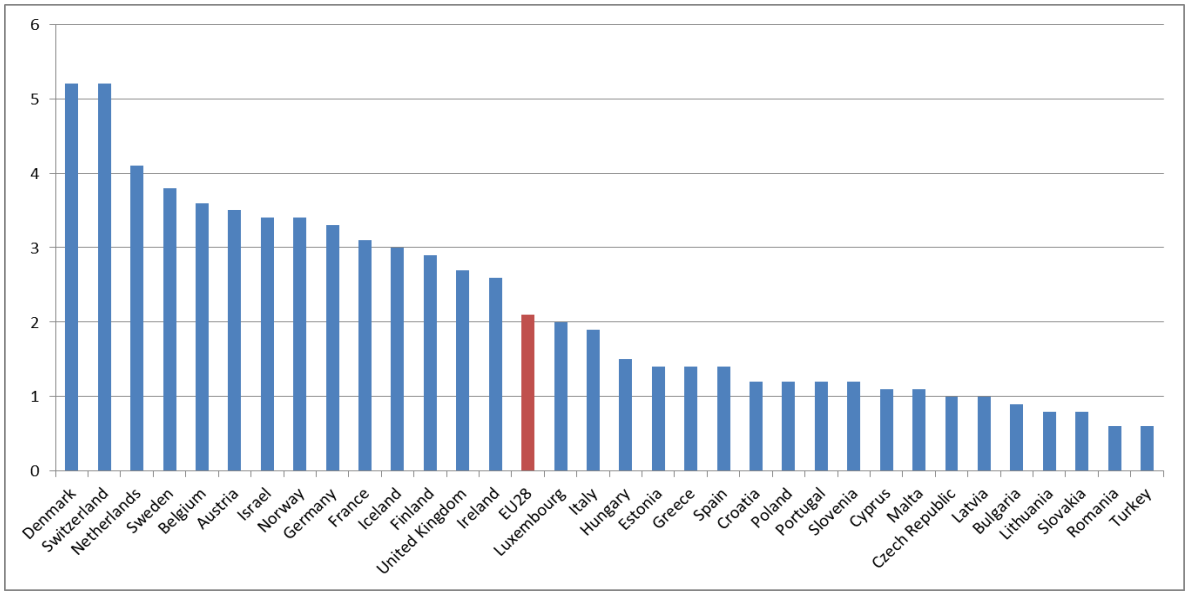

Figure 10 Public-private co-publications per country for the period 2003-2014 (in percentage of total publications)

Data: SciVal, Scopus based platform (last accessed 18 March 2016)

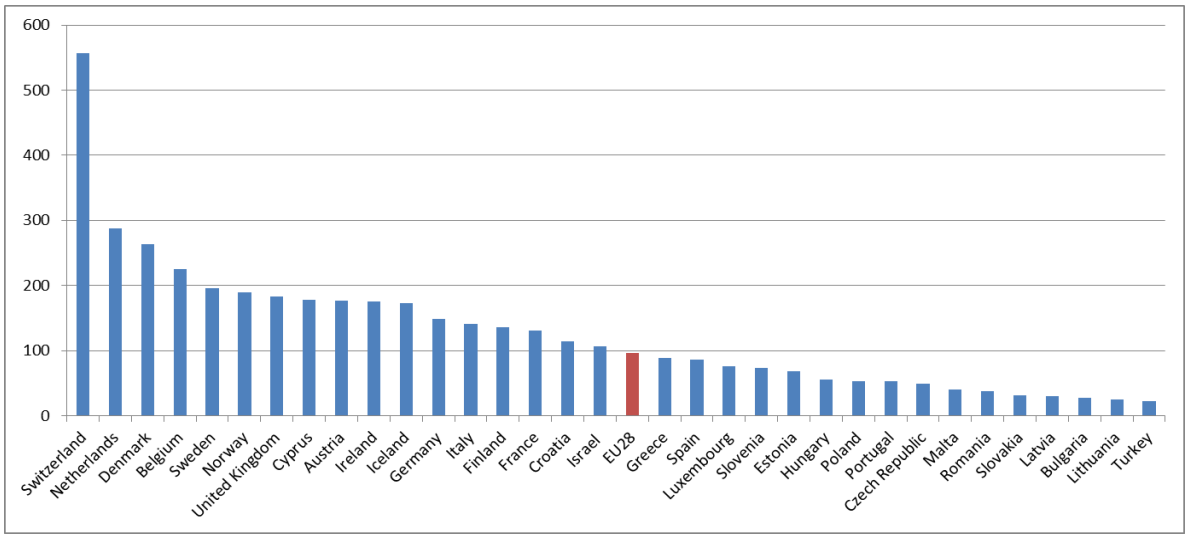

Figure 11 Public-private co-publications per country for the period 2003-2014 (per 1,000 FTE Researchers in 2014)

Data: SciVal, Scopus based platform (last accessed 18 March 2016); Eurostat*, OECD**
* Latest year available for FTE Researchers: Iceland and Turkey – 2013; Switzerland – 2012
** Latest year available for FTE Researchers: Israel - 2012

Innovative firms' cooperation patterns

The data derive from the Community Innovation Survey (CIS) 2012. The CIS (Eurostat) is based on the Oslo Manual, 3rd edition, 2005, where innovation co-operation is defined as active participation with other enterprises or institutions on innovation activities. Both partners do not need to commercially benefit. The indicator excludes pure contracting out of work with no active co-operation with higher education institutions or public research institutions for their innovation activities. This EU-wide survey is often used in studies investigating the innovation and knowledge transfer activities of European firms (Tether, 2002, Frenz and Ietto-Gillies, 2009, Cunningham and Gök, 2012). Although

most respondents still consider internally developed knowledge the most important for the firms' capabilities to innovate, R&D carried out by other organizations and collaborations in R&D with external actors is gaining a more prominent place (Frenz and Ietto-Gillies, 2009). Among the motivations for industry to tap into academic knowledge is the fact that research grows increasingly expensive. Employing a broad range of specialised staff and experts bears high costs and companies are looking to leverage external knowledge, including from universities and government research institutes (Tidd et al., 1997). HEIs are considered a highly valuable source for basic and long-term strategic research, which many firms regard as too expensive to undertake using only their own resources (Tether, 2002).

For the purpose of our analysis we therefore picked up the 1) overall share of collaboration (i.e. the percentage of "enterprises engaged in any type of cooperation) as well as the 2) share of innovative companies that are engaged in the cooperation with universities or other higher education institutions and 3) with Government, public or private research institutes. The CIS results should be treated with caution since it surveys only innovative companies with more than 10 employees and a sample of companies from a given country.

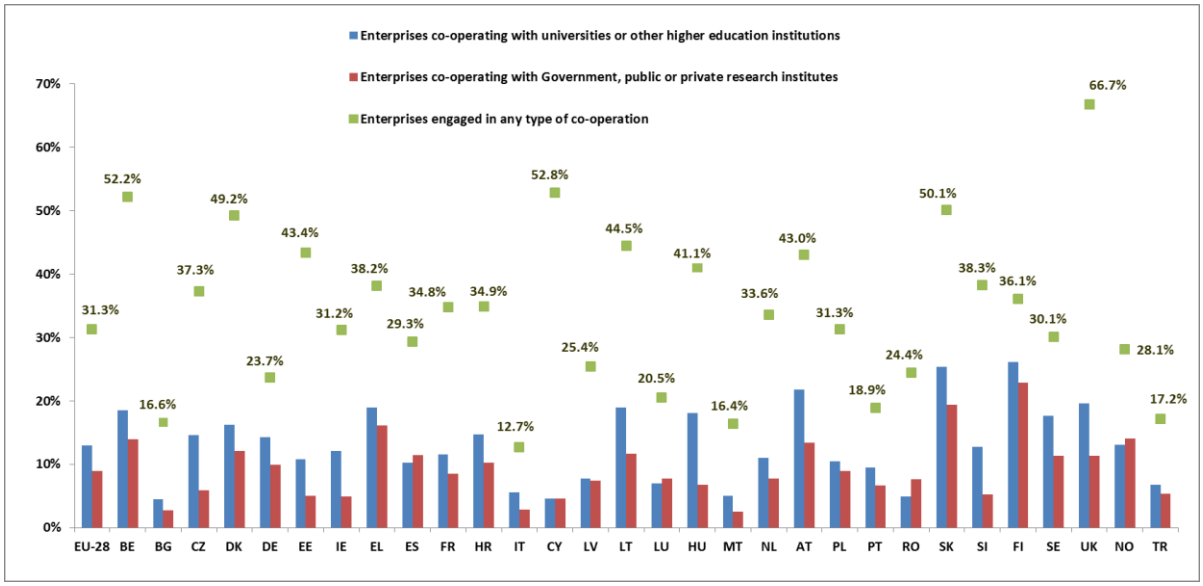

Figure 12 Types of co-operation of the enterprises (2012)

Data: Eurostat (CIS 8, 2012); data for Iceland, Israel and Switzerland are missing

Public expenditure on R&D financed by the business enterprise sector (BES)

This indicator is one of the often used measures of level of knowledge transfer. It reveals the volume of research expenditure, financed by the business sector and performed in the public sector, and therefore constitutes a monetary measurement of business engagement towards academia. This indicator is particularly relevant for "consulting activities" and "contract research" - services (outflow of knowledge) offered by universities to external clients in exchange for funding (influx of money). Both are usually combined with license agreement and jointly developed intellectual property (Perkmann and Walsh, 2007; Perkmann and West, 2014). Furthermore, contract and collaborative research are considered to be among the main mechanisms of collaboration for R&D and innovation (Cunningham and Gök, 2012). Although it is difficult to investigate on the nature of the financed activities (active cooperation or acquisition), we

think that direct investments by private companies in research carried out by academia provide clear indications of strong public-private links in R&I.

This indicator is based on Eurostat data. The "BES-financed" R&D is the amount of the R&D directly funded by the business enterprise sector. The "public expenditure on R&D" part includes the R&D performed by both higher education (HERD) and government (GOVERD) sectors. The values are expressed in both percentages of GERD and GDP.

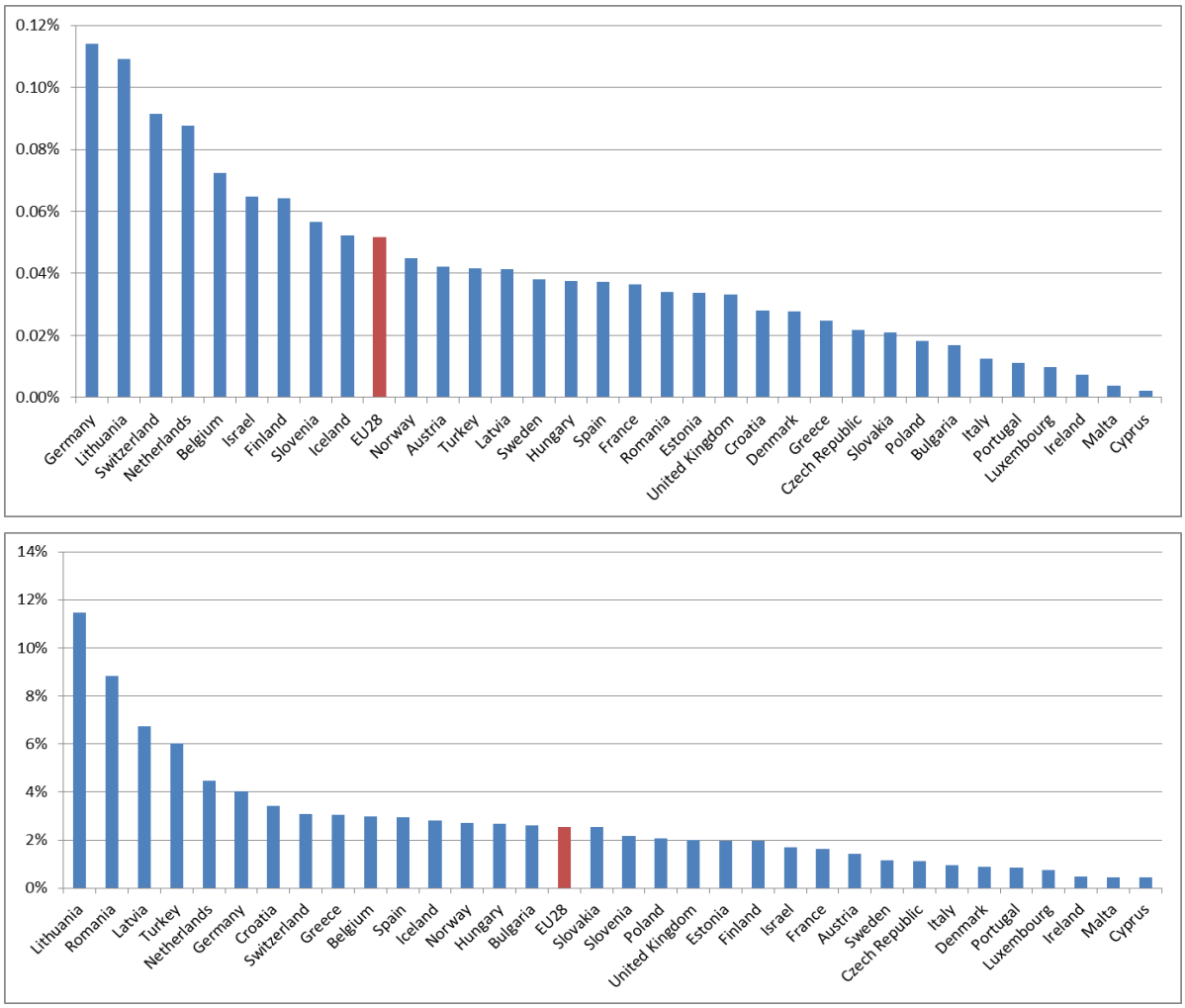

Figure 13 BES-funded public R&D per country as % of GERD (up) and GDP (below) in 2013

Data: Eurostat* and OECD**; own calculations
* All data from Eurostat (except Israel and Turkey – OECD); latest year available for Switzerland – 2012
** Data from OECD may differ because it was calculated based on USD; latest year available for Israel – 2012

Annex 2

MS	Industrial PhDs and industrial traineeships Innovative Doctorate Training		Uptake of PhDs by private sector firms/SMEs		Academic entrepreneurship and spin offs and spin-ins		Public sector research organisations: legal framework incentives (ex., dual career paths for professors)	
	Title	**Period**	**Title**	**Period**	**Title**	**Period**	**Title**	**Period**
Austria	Young experts (before Nachwuchsförderung) Industrial PhD programme	2009 2014	Young experts (before Nachwuchsförderung) FEMtech Career Paths Research Competences for Industry	2009 2004 Ongoing 2013	AplusB 2.0 Academia plus Business 2.0 Phoenix Award (BMWFW)	2001/2010- 2012		
Belgium	Flanders - Baekeland Mandates Brussels Capital: Doctiris PRODOC Programme	active 2003 2007-2013	Wallonia - FIRST Higher Education Institutes BEWARE FELLOWSHIPS – Industry R&D tax credit	1994 2014 2003	Brussels-Capital - Spin-off in Brussels Launch spin off programme Flanders: Spin-off Mandates SOFI programme Wallonia: First spin-off Flanders: Industrial Research Fund	2006 active		

					for universities			
Bulgaria	Stipends for Doctoral Students Preparing Their Theses in a National Company Innovation Fund – Industrial PhDs	2009 (closed) ongoing	x		"Tehnostart - Encouragement of innovation activity of young people in Bulgaria"	2014	Law on Innovation	Planned for 2013
Croatia	Operational programme "Human Resources Development", Measure 3.2 "Development of human resources in research and development" Young Researchers' Career Development Project – Training of Doctoral Students	2007-2014 2015	NEWFELPRO	ongoing	PoC PUBLIC (BICRO)	ongoing		
Cyprus	Penek – Young Researchers of Cyprus Programme	2009-2010	Industry Liaison Offices (ILOs) – placements of students	2010				
Czech Republic								
Denmark	Industrial PhD	1994	Industrial Post-doc	2011			Innovation strategy and PhD strategy	2012

Estonia	DoRa Doctoral Studies Internationalisation Programme DoRa Plus	2008-2015 2016	Competence Centres	2007			In SPINNO evaluation: "The Ministry is also considering the introduction of a mobility scheme and a feasibility study is currently underway. Our experience from elsewhere suggests that it could be an important component of the national innovation system and would complement SPINNO very well."	
Finland			Academy Project funding	ongoing				
France	CIFRE fellowships	1981	The research Tax Credit (CIR)		JEU-JEI PEPITE programme		Law on Innovation and research Industrial Chairs	1999

Germany	Industrial Phds		Fraunhofer Attract Programme Fraunhofer Institutes Shared Professorship programme (KIT)	X	Helmholtz Enterprise High-tech Start-up Fund (High-tech Gründerfonds) EXIST - University-Based Business Start-Ups	2005 1997	2005	
Greece			Supporting enterprises for recruiting high-level scientific personnel	2007-2013	CREATION	2007	Presidential Decree 17/2001	
Hungary	ERICSSON – BME, ELTE Industrial PhDs	x	Kozma László 5LET/IDEA Industry sponsored departments (Bosch, Audi) Human Resource Development Operational Programme (2014-2020)	2006-2009 2005 2005/2007 2014-2020	New Hungary Venture Capital Programme	2009, 2012, 2013		

Ireland	IRC Employment-based Postgraduate Programme		SFI Industry Fellowship Programme The loan of qualified personnel (for SMEs) Enterprise Partnership Scheme Elevate SFI Short-term Industry Visiting Fellowship	2013 2014 Ongoing 2013-2018 2012 2013	Enterprise Ireland New Frontiers Programme	ongoing	Knowledge Transfer Ireland	
Italy	PhD ITalents High level apprenticeship contract (regions)	2015	Tax credit for hiring "highly-qualified" personnel	2013		2013	Legislation on industrial doctorate Suppporting mobility legislation Legislation on start-ups	2013 2012-2013
Latvia								

Lithuania	Industrial doctorates	2015-2020	State Support for Employment of skilled personnel in companies	2010-2015	Technostart and INOVEKS Joint initiatives	2016		
Luxembourg	Public-Private Partnerships under the AFR	x					Support for secondment of researchers from the public sector to the private secto	2009
Malta			Loan of Qualified Experts (for SMEs)	2009-2015				
The Netherlands			Kenniswerkers	2009	Take off	2014	"bijzonder hoogleraar" (double career of university professors)	
Poland	SKILLS internships	2014-2015	KadTech Tekla	2010-2011 2007-2013	BRIdge Alfa	2013	Law on Higher Education	2011
Portugal	Doctoral degree grants in enterprises BDE	2008	Mobility grants between R&D institutions and enterprises or other entities BMOB	2008			Article 30 §1 of Decree Law No 74/2006 of 24 March 2006	2010
Romania	Mobility projects PhD - type MD	2007-2013	secondments to SMEs Competence centres (NP3) planned	2007-2013 2014-2020				

Sweden	Company graduate schools (Företagsforskarskolor) Industrial PhD project (Industridoktorandprojekt - ID-projekt)	1996 Till 2013	Development of the Knowledge Triangle Mobility for Growth VINNMER FLEXIT	2013 2012 2007-2014			Swedish Higher Education Ordinance – adjunct professor function	
Slovakia			SUSPP	2007 - 2010	VSMP	2007-2009		
Slovenia	Young researchers in the business sector[66]	2007-2010	Call for strengthening R&D departments in business enterprises (KROP) Interdisciplinary teams in the business sector Mobility grants for researchers from public sector to enter business enterprises	2011 2007-2010 2007-2010				
Spain	Industrial PhDs (PECTI)		Torres Quevedo Programme	ongoing	EMPLEA 2015 NEOTEC	2015	Science, Technology and Innovation Law (LCTI)	2011

[66] Scarce info found in ERAC evaluation and a national one, focused on brain-drain

							Spanish Strategy for Science, Technology and Innovation 2013-2020 (EESTI) PECTI 2012-2016	2012
United Kingdom	Industrial CASE Knowledge Transfer Partnerships (KTP)[67] Doctoral Training Centres	1994	Support to secondments: Knowledge Transfer Secondments Knowledge Transfer Networks Dedicated industry fellowships (.e.g. Royal Society)					
Switzerland					CTI Entrepreneurship (formerly Venturelab) provides courses and training and is mostly divided into members of universities	active		

[67] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/467141/KTP_Report_July_2015__1-SEP-15_.pdf

					the Swiss university system is very active in promoting and launching start-up initiatives: ETHZ (253 start-ups), EPFL (201), the University of Zurich (50), the University of Saint Gallen (33) and the University of Basel (33)	active		
Israel	MAGNET Nofar		National Program for the Return of Israeli Academics		Young Entrepreneurs			
Iceland								
Norway	Industrial PhD scheme	2008,			New pilot scheme for support to students and PhDs who want to engage in entrepreneurship	2016		

Turkey	Industrial Thesis Supporting Program (SAN-TEZ)[68]	2007?			Technology Development Zones (TDZs) -	2014?	Co-Funded Brain Circulation Scheme National Science and Technology Human Resources Strategy and Action Plan (2011-2016)	

[68] https://biltek.sanayi.gov.tr/Sayfalar/en-us/santez.aspx

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