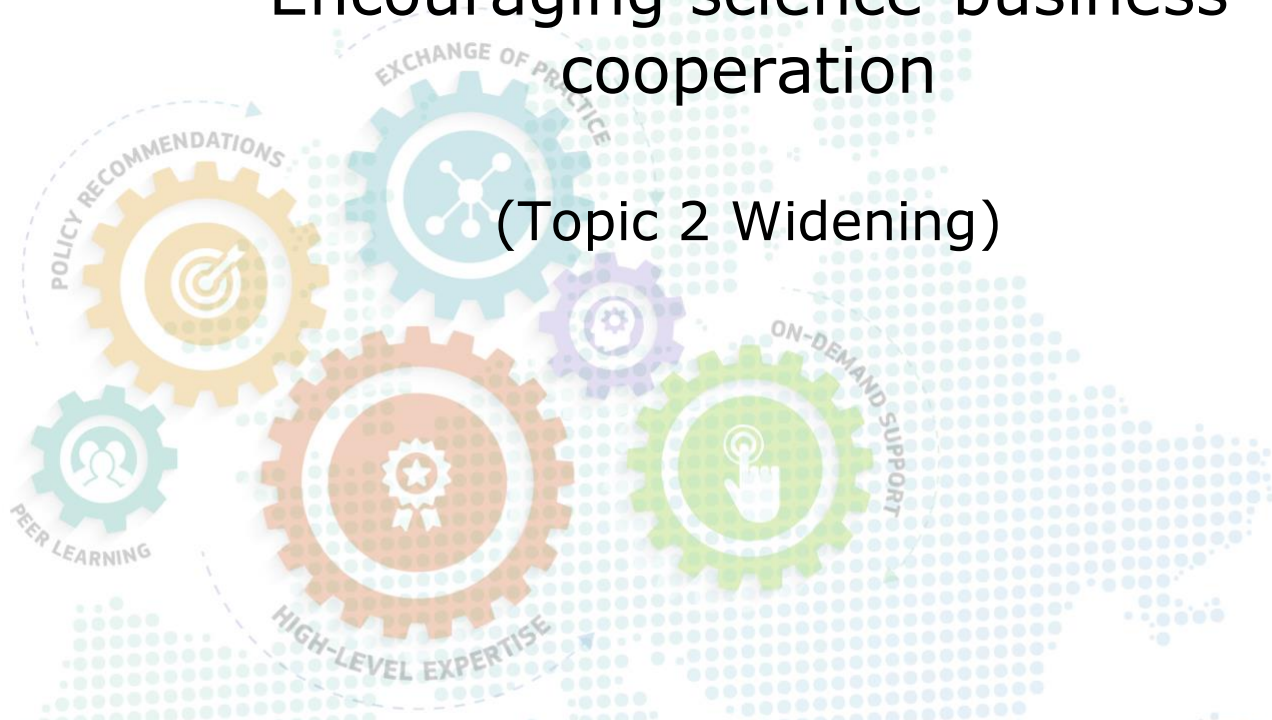


Mutual learning exercise (MLE) on national practices in widening participation and strengthening synergies

Challenge Paper:
Encouraging science-business
cooperation

(Topic 2 Widening)



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MLE Widening participation and strengthening synergies: Challenge Paper: Encouraging science-business cooperation (Topic 2 Widening)

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Mutual learning exercise on National practices in widening participation and strengthening synergies

**Challenge Paper:
Encouraging science-business
cooperation
(Topic 2 Widening)**

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Foreword

This document has been prepared under the auspices of the Policy Support Facility (PSF) set up by DG Research and Innovation under H2020 to support countries in reforming their research and innovation (R&I) systems. It is one of a series of reports drafted as part of a Mutual Learning Exercise (MLE) on 'Widening Participation and Strengthening Synergies' (WPSS).

Widening participation in the Framework Programme (FP) can help countries tap into their unexploited R&I potential and improve overall R&I system performance.

Ensuring and strengthening synergies between activities supported by the FP and those supported by European Structural and Investment Funds (ESIF) can improve the overall efficiency and effectiveness of public funding for R&I and enhance the performance of R&I activities.

Thirteen countries (Belgium, Bulgaria, Cyprus, Croatia, Germany, Hungary, Latvia, Poland, Portugal, Slovenia, Sweden, Spain and Turkey) are participating in the MLE, with Germany participating as an Observer.

The schedule for the MLE called for Challenge Papers covering different aspects of 'Widening' and 'Synergies' to feed into discussions at a series of four workshops, prior to the production of Topic Reports based on these discussions and relevant material contributed by participating countries.

The aspect of 'Widening' covered by this Challenge Paper is Topic 2: 'Encouraging science-business cooperation'.

1. Introduction

Bridging the gap between science and industry is a long-standing and permanent concern of all governments wishing to reap the benefits of the knowledge-based economy for economic growth and employment.

For many years in Europe it has been referred to as the need to respond to the 'European Paradox', namely Europe's "*comparatively limited capacity to convert scientific breakthroughs and technological achievements into industrial and commercial successes*"¹. The EU 1995 Green paper on innovation² proposed 13 routes to foster innovation: one of them was to "*better direct research efforts towards innovation*", which includes the idea of "*strengthening the mechanisms linking basic research and innovation; focusing on markets with high growth potential, such as prime sectors and 'green' markets*".

The 1997 OECD report 'Technology, Productivity and Job Creation – Best Policy Practices'³ claims that to realise the full potential of technological change to improve economy-wide productivity, growth and job creation, governments need to make innovation and technology diffusion policies an integral part of overall economic policy. Amongst the wide range of needed reforms, the OECD points to the importance of "*improving the management of the science base via increased flexibility in research structures and strengthening university-industry collaboration*".

The attention to boosting linkages between science and industry has not faded out over time. However, it has evolved from a linear concept of 'transferring knowledge from science to industry' towards an interactive view, inspired by the innovation system concept, where 'co-creation of knowledge' by actors from the public research side and businesses is put under the spotlight. Another evolution is that the international dimension of these partnerships is increasingly emphasised. This is visible in the 2010 Flagship Initiative Innovation Union⁴. In this document, one of the 10 features of a well-performing national and regional research and innovation systems is the following: "*Partnerships between higher education institutes, research centres and businesses, at regional, national and international level, are actively promoted*". That feature includes traditional actions with a view to ensuring technology transfer as well as a move towards the establishment of cooperative innovation platforms, involving actors from science and from business. The 2015 OECD Innovation Strategy 'Agenda for Action' follows the same line in claiming that "*the broader system of knowledge creation and diffusion is equally important for productivity growth; more intensive collaboration between firms and universities is associated with more diffusion of foreign technologies*".⁵

The European FPs have evolved over time, paying growing attention to public-private collaboration in research and innovation, with Horizon2020 aiming "*to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation*"⁶. Hence reinforcing such cooperation capacities, at regional and national level, is an important prerequisite for enhanced participation and improved success rates in FP. This goal is often at the core of smart specialisation strategies and hence a priority in using European Structural Funds.

¹European Commission (1994), *White Paper "Growth, Competitiveness, Employment. The Challenges and Ways Forward into the 21st Century"*, Chapter 4.

²European Commission (1995), *Green Paper on Innovation*.

³OECD (1996), *Technology, Productivity and Job Creation – Best Policy Practices*, OECD Publishing, Paris.

⁴European Commission (2011), *Europe 2020 Flagship Initiative Innovation Union, SEC(2010) 1161*.

⁵OECD (2015), *The OECD Innovation Strategy: an agenda for action*, OECD Publishing, Paris.

⁶<https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020>

The focus of this paper is on ways and means to encourage science-business cooperation, with a view to widening participation in the FP.

The paper serves as a background document for the May 2018 workshop organised in Brussels under the EU Policy Support Facility Mutual Learning Exercise (MLE) devoted to Widening Participation and Strengthening Synergies between FP and ESIF. The present Topic was identified as a priority issue when the MLE was designed by the participating countries. During the workshop, representatives from Member States and Associated Countries will present and share their good practices aimed at improving science-business cooperation in research and innovation.

The scope of the 'Encouraging science-business cooperation' Topic is detailed in section 2. An overview of the landscape of relevant reforms, initiatives, incentives, programmes and structures to encourage science-business cooperation is presented in section 3. Lessons learned from existing practice with respect to the policy mix used to support science-business co-operation and to a subset of instruments within this mix are exposed in section 4. The final fifth section identifies main challenges that should be addressed in the MLE and proposes issues to be debated at the workshop.

2. Scope

2.1. Definition of the topic

The policy goal of encouraging science-business cooperation is, as mentioned above, at the core of innovation strategies in all countries and hence national (and regional) policy mixes include a wide range of instruments, some with a long history, dedicated to the promotion of such linkages, providing a fertile ground for exchanges of experiences and learning from good practices.

Strengthening science-business cooperation means implementing actions on three fronts:

- **On the 'science' side:** there is a need to ensure that Higher Education Institutions (HEIs) and Public Research Organisations (PROs) incorporate technology diffusion, research commercialisation and working in partnership with actors from outside the public research sector as part of their missions. This requires reforms, new strategies and the setting up of incentives and structures to facilitate such activities, while at the same time upgrading capacities to increase excellence in research and education;
- **On the 'business' side:** companies need to develop the skills to interact and cooperate with the public research sector, as well as the capacity to absorb research results or technology developments coming from this sector. More fundamentally, companies need to be innovation-aware and involved in innovation and/or research activities: a weakly innovative business sector is often the main reason for the paucity of science-business relationships⁷;
- **At the interface between 'science' and 'business':** cooperation platforms, intermediary structures such as science and technology parks or technology transfer offices, and incentives play a role in providing the space for co-creation of knowledge, and for joint work on research and technology development activities. The mobility of people between the two sectors provides the necessary linkages through the circulation of embodied knowledge.

This topic covers the structures, the funding programmes or schemes and the non-financial incentives⁸ that target either the science sector or the business sector, or both, and aim at facilitating the connection, the cooperation and the partnerships between actors from those two sectors.

It should be noted that the policy goal of strengthening science-business cooperation is also a priority for regional-level strategies, since regions are in charge of economic development in their territory and most have embraced innovation as core to their regional development strategies. Hence many of the instruments in the landscape presented in the next section are (also) the responsibility of regional authorities, and (often) funded by ESIF.

While the Landscape section 3 describes the relevant science-business cooperation policy mix and the Lessons section 4 contains general lessons relevant to the construction of policy mixes, it was outside the scope of this MLE to consider lessons relevant to all individual instruments in this policy mix. Section 4 does include lessons relevant to three instruments: TTOs, Industrial PhDs and Collaborative R&D Programmes.

⁷ For example, a recent analysis in Slovenia concluded that “*the lack of companies with in-house R&D activities is the main structural deficit for more science-industry cooperation.*” Bucar, M. and M. Rojec (2015), Science-industry cooperation in Slovenia: determinants of success, *Economic and Business Review*, Volume 16, n°3, 315-336.

⁸ Non-financial incentives take the form of strategy development, changes of rules, new governance systems, etc.

2.2. Complementarity with other topics covered by this MLE

The challenge of enhancing participation to FP will not be met solely by initiatives aimed at encouraging science-business cooperation. Other significant routes are addressed in the other 'widening' Topics covered in this MLE, specifically:

- **Topic 3: Improving networking through participation in EU-level initiatives:** networking at EU level also covers participation in public-private partnerships. Groups of interlinked actors at national (or regional) level will find it easier to participate in EU networks if they can rely on well-functioning cooperative networks at home;
- **Topic 1: Attracting qualified R&D staff in the public and private sectors:** the (inward and outward) international mobility of researchers is a good way to reinforce research and innovation systems. Sectoral mobility (between science and industry) both on a national and on an international scale is complementary to international mobility within the same sector.

Discussions relevant to the theme of **synergies** between the use of European Structural and Investment Funds (ESIF) and FP funds (covered under Topics 5, 6 and 7 of this MLE), at both strategic and operational levels, are also complementary to the present Topic. Many instruments part of the landscape presented in section 3 are funded with ESIF, given their potential in bringing knowledge-based development in EU regions.

Finally, this Topic is also complementary to two other MLE exercises, both ending in 2017:

- The **MLE on Evaluation of complex PPP programmes in STI**⁹. This MLE addressed complex Public-Private Partnership (PPP) programmes that supported strategic (often virtual) centres or network-type organisations conducting sector- or challenge-based research involving multiple partners and promoting public-private collaboration in STI. Instruments of this type, which are part of the landscape discussed in the next section, are increasingly used to promote science-business cooperation in contemporary innovation policies, since they explicitly aim at the co-creation of knowledge by actors from the private and public spheres.
- The **MLE on Performance-based Funding of Public Research Organisations**¹⁰. This MLE assessed the various models used to link funding for PROs to achievements, including achievements in terms of bridging the gap between science and industry and delivering research and education outputs and outcomes of relevance to industry and society. Notably, the MLE included a discussion on metrics that can be used to assess the contribution of PROs to innovation in industry.

⁹ <https://rio.jrc.ec.europa.eu/en/policy-support-facility/mle-evaluation-complex-ppp-programmes-sti>

¹⁰ <https://rio.jrc.ec.europa.eu/en/policy-support-facility/mle-performance-based-funding-systems>

3. Landscape

The landscape of instruments aimed at facilitating science–business cooperation is depicted in Table 1 (in bold: instruments that are subject to further scrutiny in Section 4). The rest of this section includes a brief description of the elements of this landscape.

Table 1. Landscape of instruments to encourage science-business cooperation

Structures	Funding programmes	Non-financial incentives
INSTRUMENTS TARGETING THE PUBLIC RESEARCH SECTOR		
Research and Technology organisations	Change in funding rules for HEIs and PROs to take into account work with industry	Reorienting public research towards the needs of industry
Technology Transfer Offices	Incentive schemes for start-ups	Rewarding work with industry in academic career paths and salaries
	Proof-of-concept schemes for HEIs/PROs	Engagement strategies of HEIs/PROs (third mission, IPR rules, student placements and entrepreneurship, sabbaticals in industry, etc.)
INSTRUMENTS TARGETING THE BUSINESS SECTOR		
Business advisory services, innovation centres acting as bridges to HEIs/PROs, and as matchmakers	Innovation/knowledge/R&D voucher schemes for SMEs	
Innovation Clusters	Support schemes for hiring researchers in companies, placement schemes	
INSTRUMENTS TARGETING THE INTERFACE BETWEEN THE TWO SECTORS		
PPP complex programmes (centres or networks) and joint research units (<i>covered in another MLE</i>)	Funding programmes for collaborative research projects (generic, thematic)	Mechanisms and protocols for joint use of research infrastructure
Science and technology parks	Industrial PhD schemes	Involvement of businesses and HEIs/PROs in national/regional innovation strategies and platforms
	Sectoral mobility schemes for researchers	Engagement of industry in HEIs/PROs

Source: author.

3.1. Instruments targeting the public research sector

Research and Technology Organisations (RTOs) are public¹¹ research organisations with a mandate to cooperate with industry either through technology diffusion or joint technology development activities. RTOs are non-profit research organisations with a main mission to carry out research and technology development oriented to the needs of the economy, including contract research and innovation. In addition, they usually provide a range of services to industry, including testing, access to equipment, certification, prototyping, ad hoc training, etc. The common view is that those types of structures provide an easier connection between, on the one hand, developments in science/research and, on the other hand industrial development, than HEIs, which do not have this diffusion mission as a core aim.

- In **France**, Carnot Institutes¹² were established in 2006-2007 through a competitive procedure. These were existing organisations that had a proven capacity to conduct research in partnership with industry, either through contract research or through cooperative research. The Institutes carry out research on their own in order to improve their knowledge base, and research in partnership with companies (large and small). The Carnot label is awarded for a (renewable) period of 4 years and gives access to specific national funding lines for cooperative R&D. The Carnot Institutes account for 18% of human resources in the public research sector and are responsible for 50% of research funded by the private sector in public research. The main outcomes of Carnot Institutes are publications, patents and spin-offs. They also implement proof-of-concepts and technology demonstrators.

The funding sources of RTOs combine, in different proportions: 1) basic funding from national or regional governments, with the aim of maintaining a research base and developing skills; 2) competitive funding acquired through access to EU, national and regional (applied) research programmes; and 3) private funding gained through contract research and services to industry. Due to their mission of contributing to the technological development of industry, RTOs are frequent recipients of ESIF funds at regional or national level, either on a structural or on a project basis.

Since RTOs are public organisations, they differ from complex Public-Private partnerships (see below section 3.3), which are joint initiatives between the public and private sector.

Technology transfer offices (TTOs) are widely used to foster science-industry relationships. Their traditional role is to manage the commercial exploitation of university research through the administration and licensing of intellectual property rights. The existence of TTOs is linked to the widespread ownership by universities of the IPR on research conducted in their laboratories (see below). Some TTOs offer extensive services covering pro-active scouting for research ideas with commercialisation potential, training researchers for exploitation of research results, advice on regulations, matchmaking services with business partners, etc. Some universities promote the creation of TTOs with specific legal personality.

- The TTO of the University of Leuven in **Belgium**, KU Leuven Research & Development (LRD)¹³, is a well-known example of a vanguard TTO that implements an effective technology transfer policy for the university. LRD has developed a solid tradition of collaborating with industry, securing and licensing intellectual property rights, creating spin-off companies and stimulating knowledge-driven regional development. LRD supports researchers throughout the entire knowledge and technology transfer process and helps them to best leverage the societal and economic potential of their research. Its activities

¹¹ In some cases, RTOs have a private status, but are regular recipient of public funds under different modalities.

¹² <http://www.instituts-carnot.eu/>

¹³ <http://out.easycounter.com/external/lrd.kuleuven.be>

include: supporting collaboration with industry based on well-balanced collaboration agreements; managing intellectual property; support to the creation of spin-off companies, including access to incubators and science parks and advice concerning access to seed capital; promoting entrepreneurship and innovation by stimulating networking initiatives, such as Leuven.Inc (Leuven Innovation Networking Circle), and technology clustering; and stimulating and cultivating knowledge-driven regional development.

TTOs are grouped into national associations: according to the EU association AST-Proton Europe¹⁴, there are 29 such national associations across Europe representing 9,000 professionals working in more than 500 offices.

- The C.U.R.I.E. Network¹⁵ in **France** established 27 years ago, gathers professionals of technology transfer and innovation from public research organisations of France. With 190 institutional members, involving about 1400 professionals, C.U.R.I.E. has a mission of promotion, development and of professionalisation of technology and knowledge transfer managers in public research organisations.

Lessons learned with respect to design, implementation and success factors for TTOs are covered in more detail in Section 4.2 below.

Change in funding rules for HEIs and PROs to take into account work with industry is an important incentive to 'bridge the gap' between science and industry. Another goal pursued by HEIs and PROs is simply the need to capture additional funds. In most countries basic funding schemes for HEIs emphasise academic research and teaching, paying little attention to additional the requirement for universities to perform knowledge transfer and contribute to innovation activities. This gap is often less present for technical universities, which have easier access to, and are more inclined to cooperate with, industry as part of their education and research mission. In a few countries, where the 'third mission' is explicitly part of the mission of HEIs (see below), governments have introduced rules to link funding with the accomplishment of this third mission. As part of this effort, third stream metrics have been introduced in a few countries to measure this kind of achievement. This issue has been studied in another MLE¹⁶ devoted to performance-based funding systems.

In addition, in recent times, there has been a growing trend of introducing more competitive funding models, and a shift in balance of funding in favour of performance-related funding for PROs. In many cases, serving industry needs and contributing to new developments of interest to industry are part of the definition of 'performance' (see also 'PPP complex programmes' in section 3.3).

- In **Estonia**, since 2017, the baseline funding formula for R&D in the public sector has been changed to put more weight on work with industry and involvement in transnational research. The new formula includes the following criteria and weights¹⁷: 50% for research revenues from abroad and business sector contracts (up from 40% previously); 40% for scientific publications and number of patents and patent applications (down from 50% previously); 10% for number of defended PhD theses and 5% for research of national importance.

¹⁴ <https://www.astp-proton.eu/>

¹⁵ <https://www.curie.asso.fr/>

¹⁶ MLE on Performance-based Research Funding Systems (PRFS), Third Stream Metrics in PRFS, Thematic Report No 4 <https://rio.jrc.ec.europa.eu/en/policy-support-facility/mle-performance-based-funding-systems>

¹⁷ Tubli, U. (2015), *Industry-University interactions Estonian case*, presentation at the May 2th 2015 OECD TIP KT Workshop in Paris.

Incentive schemes for academic start-ups are widely used in response to some of the key problems faced by entrepreneurs from academia: 1) the lack of finance available at the early stage of firm creation based on an innovative idea, due to the high commercial risks involved; and 2) the need to complement scientific and technological expertise from academic founders with market knowledge and skills. Start-up programmes often combine funding, infrastructure and soft advice for academic entrepreneurs (and proof-of-concept schemes, see below).

- In **Austria**, the AplusB-centres¹⁸ (Academia plus Business programme), started in 2002, constitute a network of business incubators that aim to support academic spin-offs. The centres provide an integrated bundle of measures targeted at scientists from universities, Fachhochschule colleges and non-university research institutions: counselling, know-how and support; infrastructure facilities (laboratories, offices etc.); financial support; providing optimal start-up conditions for the new companies by cooperating with potential investors and with other funding programmes and the regional network; awareness-raising, mobilisation and stimulation of start-up activity (events, information campaigns, professorships for entrepreneurship etc.) addressed to young scientists, and – in particular – to students and professors.
- In **Denmark**, the Innofounder programme¹⁹ is a one-year incubator programme that provides guidance and funding for new graduates with an innovative and scalable business idea. It provides a monthly grant of DKK 15,000; a special grant of DKK 35,000 to support the development of business ideas; a place in a co-working space; availability of an experienced mentor; workshops with other InnoFounders and experts; access to the InnoFounder community of investors, start-ups and corporate professionals in Denmark and internationally.

Proof-of-concept schemes for HEIs/PROs are funding schemes that aim to increase the Technology Readiness Scale (TRL) level of the outputs of research projects carried out in the public research sector, thus bringing them closer to commercialisation. Proof-of-concept schemes fund activities aimed at bridging the gap between results from research projects conducted in academia and the needs of businesses in terms of: industrial transferability of a new technology; repeatability of the results; the feasibility of scaling up the technology; the suitability of the technology in commercially relevant applications; as well as the eventual scope of the intellectual property protection. These types of activity are not usually covered by the funding schemes available to researchers in HEIs/PROs, hence there is a need for proof-of-concept funding because research projects are normally not continued up to that stage.

- In **Finland**, the Tutli²⁰ programme is aimed at research groups and researchers in research organisations who want to create new business with their research and commercialise their ideas. At least 40% of the project costs must be targeted at the preparation of commercialisation of research results.
- The **EU** European Research Council (ERC)²¹ launched a Proof of Concept scheme in 2011 to help ERC grantees bridge the gap between their pioneering research and early phases of its commercialisation. Since 2011, it has backed nearly 800 projects. Worth up to €150,000 per grant and open only to ERC grantees, the funding can be used, for example, to establish intellectual property rights, investigate business opportunities or conduct technical validation. The 2017

¹⁸ <https://www.ffg.at/en/aplusb-academia-plus-business>

¹⁹ <https://innovationsfonden.dk/en/investment/innofounder>

²⁰ <https://www.businessfinland.fi/en/for-finnish-customers/services/funding/research-organizations/in-brief/>

²¹ https://erc.europa.eu/news/review_praises_erc_poc_scheme

review²² of the scheme concluded that the scheme is "sound in concept and effective in practice" and that it has a powerful additionality effect. It was effective in helping ERC-funded scientists set up new companies, file patent applications and attract capital to make their research marketable.

Reorienting public research towards the needs of industry is a goal pursued by many governments wishing to reap more benefits from public research. In the last two decades, there has been a surge in national research policies with features aimed at increasing the social and economic benefits from research activities, in particular the benefits accruing to industry. This is done through: 1) the launch of thematic research programmes, targeting specific sectors or activity domains of importance for national (or regional) economies; and 2) the inclusion of 'valorisation' criteria in some research funding programmes, namely the requirement that research is carried out with a view to its further exploitation in the economic sector.

- The recent peer review of **Poland's** Higher Education and Science System²³ finds that HEIs are not incentivised to conduct research activities of benefit to society and industry. The legal obligation for HEIs to spend 2% of their core funding on technology transfer activities does not meet the need. And there is also a disincentive to engage in such activities, since "*institutions with the greatest research capacity win national projects too easily and do not need to look for industry collaboration*".
- In **Spain** the most useful instrument was to launch specific calls where companies are required to find an agreement with a HEI or PRO to be able to submit a research proposal.

Rewarding work with industry in academic careers and salaries is a condition for universities to become more 'entrepreneurial' and able to conduct a 'third mission' (see below). Traditionally, researchers and professors are evaluated and promoted almost exclusively on the basis of their scientific achievements measured through number and quality of scientific publications. To encourage science-industry cooperation, work with industry needs to be recognised as a valuable achievement along an academic career path. Taking account of this type of activity, however, is not straightforward. Counting patents filed by university researchers is one option, but it is an imperfect one as it does not necessarily lead to an uptake of research results by industry (see below). Freeing time for researchers and professors to work with industry (in parallel with teaching and academic research duties) is another way to promote and acknowledge the relevance of this type of activity in academic careers. Another issue that needs to be resolved is the possibility of topping-up salaries with revenues from industry, a feature that exists only in some EU countries and universities. Finally, rules for accessing university laboratory and equipment for the purpose of conducting work with industry need also to be adopted in order to provide a stable and transparent framework for such collaborative activities.

- In **Spain**, cooperation with industry is encouraged at the highest level in the University Law (article 83). Based on that law, faculty members which participate in R&D and innovation projects with industry through the University can top-up their annual salaries up to three times the salary of a full professor (distribution depends on the budget and decisions made by the principal investigator of the project). The amounts received are not consolidated in the salaries and depend on the signature of specific agreements with industry. This possibility has been used since the 80's as a powerful incentive to promote cooperation with industry and

²² Wessner, C. and F. Munari (2017), An Empirical Assessment of the ERC Proof-of-Concept Programme, report to the ERC Executive Council, https://erc.europa.eu/sites/default/files/document/file/poc_review_report.pdf

²³ European Commission – DG Research and Innovation – Horizon 2020 Policy Support Facility (2017), *Peer Review of Poland's Higher Education and Science System*. <https://rio.jrc.ec.europa.eu/en/policy-support-facility/peer-review-polish-higher-education-and-science-system>

also to better align the research agenda to industry interests. Nowadays, all Spanish public universities are applying it through internal regulations.

While this possibility to top-up salaries has provided the incentive for increasing university-industry cooperation within isolated R&D projects, additional effort was needed to set-up long-term partnerships. This issue was explicitly promoted through the Spanish programme of International Campus of Excellence launched in 2007. One of the main drivers for the award of 'excellence' to universities was the setting-up of 'aggregations' (stable agreements) between universities and public and private entities. Even when the majority of cases of aggregations were formalized between universities and research centres, in some cases companies were also involved in the process by creating joint units. In this context, additional governmental funds could not be used to top-up salaries but individual projects funded by companies increased over years where the topping-up regime of salaries applied.

Engagement strategies of HEIs/PROs aim to ensure that education and research conducted at HEIs/PROs benefit society at large. This goes much beyond a narrow approach focusing on technology transfer. What such strategies entail and the way they are implemented is a multi-faceted phenomenon. Engagement strategies are closely linked with the adoption in national law of a 'third mission' for universities, which gives them the duty to develop strategies for the implementation of this mission.

- In 1997, **Sweden** assigned by law a 'third mission' to HEIs in addition to the first two missions, research and education. The concept of collaboration is included in the Swedish Higher Education Act as one of the key assignments of the country's universities and HEIs. It aims to create the basis for academic findings to be of benefit outside of academic contexts. Joint work between academia and businesses provide the basis for knowledge development that responds not only to scientific motivations, but also takes into consideration societal benefits. For the business sector, the collaboration creates the conditions for long-term development by providing companies' access to the latest research.
- **Turkey** has introduced an Entrepreneurial and Innovative University Index²⁴, which assesses the achievement of universities in terms of boosting innovation and entrepreneurship. The index captures 5 dimensions (based on 23 indicators in total): scientific and technological research competence; intellectual property; collaboration and interaction; entrepreneurship and innovation culture; and economic contribution.
- The recent peer review of **Poland's** Higher Education and Science System²⁵ indicates that HEIs in this country have not yet embraced a 'third mission': *"Despite the changes following the Science and Higher Education Reform of 2010-2011, the HEIs' third mission and their engagement with society and industry remain challenges: action is limited to a narrow range of activities, with emphasis on research publications, graduating students and mostly linear models of knowledge transfer. The related policies in HE and R&I in Poland primarily focus on technology transfer, copying US-style commercialisation efforts, which are unlikely to yield the expected results, while disregarding a broader knowledge exchange and the role of HEIs in addressing societal challenges"* (European Commission 2017).

²⁴<https://www.tubitak.gov.tr/en/news/the-entrepreneurial-and-innovative-university-index-2016-has-been-announced>

²⁵ European Commission – DG Research and Innovation – Horizon 2020 Policy Support Facility (2017), *Peer Review of Poland's Higher Education and Science System*. <https://rio.jrc.ec.europa.eu/en/policy-support-facility/peer-review-polish-higher-education-and-science-system>

Engagement strategies are translated into bottom-up voluntary moves by HEIs/PROs wishing to give more prominence to societally-relevant activities, in line with concepts such as 'Responsible Research and Innovation'. Those bottom-up strategies are justified by the positive relationship, found in many studies, between excellence of research and engagement in industry, even if this link is more firmly established for technology-oriented and medical disciplines than for social sciences (Perkmann et al. 2011)²⁶.

- The **Irish** Universities Association has developed a framework for 'engaged research'²⁷, which aims at developing a broad range of enhanced engagement practices between higher education institutions and society, including harnessing the research strengths of higher education institutions to address grand societal challenges, spanning a range of disciplinary fields. This framework builds on existing practices by HEIs already at play throughout Ireland and makes proposals in order to: define research questions in partnership with 'community partners'; put value in knowledge held by partners outside academia; elaborate clear rules and agreements for collaboration between academic researchers and community members; ensure utilisation of research results by relevant actors in society; and design planned outputs in line with societal challenges at stake.

Encouraging university patenting is one way to foster the engagement of HEIs and PROs with research that has application and commercial potential.

- Uni:invent, run by the **Austrian** Business Agency AWS and financed by the Federal Ministry for Science and Research, was a funding mechanism run from 2004 to 2009 to enforce patenting by universities, first by providing coaching for universities and researchers in the patenting process and, secondly, by providing financing for university patents.

Lack of clarity over the ownership of IP in research collaborations is an important barrier to the commercialisation of university research.

- The 2015 Peer Review²⁸ of the **Bulgarian** research and innovation system points out that the country failed to set-up an institutional level legislation covering the identification, protection and efficient transfer of intellectual property of all types from PROs to the private sector (except for the Bulgarian Academy of Science): *"without this institutional framework entrepreneurial researchers will continue to commercialise research privately. This informal approach not only fails to benefit the PRO, it also tends to keep commercialisation activity artificially low as Bulgarian researchers do not want to draw attention to their 'gray' activities and also lack the necessary support to realise the full potential of their inventions."*

IPR rules differ from country to country:

- An institutional ownership model is at play in the majority of countries: in this system, university researchers are obliged to report their inventions to the university, which owns the IPR. In countries like **Spain** a minimum of 50% of royalties should be allocated to inventors (researchers) not only from patents but also from any IP;

²⁶ Perkmann, M., King, Z. and Pavelin, S., 2011. Engaging excellence? Effects of faculty quality on university engagement with industry. *Research Policy*, 40 (4), pp. 539-552. <http://opus.bath.ac.uk/26444/>

²⁷ Irish Universities Association, Irish Research Council (2017), *Engaged Research: Society and Higher Education, addressing grand societal challenges together*. <https://www.iua.ie/publication/engaged-research-society-and-higher-education-addressing-grand-societal-challenges-together-2/>

²⁸ European Commission – DG Research and Innovation – Horizon 2020 Policy Support Facility (2015), *Peer Review of the Bulgarian Higher Education and Science System* <https://rio.jrc.ec.europa.eu/en/policy-support-facility/peer-review-bulgarian-research-and-innovation-system>

- Under the 'professors' privilege' rule in **Sweden**, IPRs are owned by the individual inventor, not the university;
- **Poland** has implemented a mix of institutional and inventor ownership model.

According to (OECD 2002)²⁹, "a good practice is to grant IP rights to the performing research organisation while ensuring that individual researchers or research teams can share the rewards". Recent work emphasises the importance of 'soft IPR', such as copyright, open source, trademarks and design rights (Andersen and Rossi 2010)³⁰. These various forms of IPR are used in a complementary way, hence formal patents are only part of the picture of university-business knowledge transfer. According to a UK enquiry, larger universities tend to use patents more intensively, while older universities and former polytechnics use all forms of IPR (Andersen and Rossi 2010).

Engagement strategies of HEIs/PROs also translate into a wide range of initiatives related to research staff mobility. These includes: the promotion of student entrepreneurship, student placements (internships, sandwich courses) in industry, sabbatical periods for professors in industry, joint supervision of students Master or PhD theses (see below Industrial PhD), etc.

Finally, including entrepreneurship courses in universities, open to students from all disciplines, is another element of the strategies of universities willing to foster their engagement with industry.

3.2. Instruments targeting the business sector

Business advisory services and innovation centres may be acting as bridges to, and as matchmakers towards HEIs/PROs. However they are seldom seen as being part of the policy mix for science-business cooperation. Nevertheless, from a business point of view, and especially for SMEs, these are often more natural counterparts for innovative activity than public research organisations. Hence these business-oriented organisations have a good potential to raise awareness of innovation in companies, promote partnerships with public research performers and help find relevant partners and funding sources for joint research and innovation activities.

- The **Swedish** Industrial Development Centres³¹ (IDCs) constitute a network of regional business advisory centres specialised in specific areas of activities. The 22 centres have a mission to foster innovation in SMEs, to support the development of innovative products in companies and to facilitate the establishment of spinoffs. They were established in 1993 as a private initiative. In 1997, the Swedish government opened a funding line for these centres, based on the recognition that more attention should be given to SMEs in a Swedish economy dominated by large firms. The IDCs remain under majority ownership by companies. The public mission of IDCs takes the form of: follow-up of product development projects; pre-study for the formation of spin-offs; and visits to companies to raise innovation awareness. The aim of these activities is to identify potential ideas and help firms engage in more innovative projects. IDCs provide loans at a favourable rate at the start of risky product development projects. The work of the IDCs also involves fostering contacts and networking among firms and between firms and research organisations. IDCs act as technology brokers and intermediaries, helping to find relevant partners and financial sources. In some

²⁹ OECD (2002), *Benchmarking science-industry relationships*, OECD Publishing, Paris.

³⁰ Andersen, B. and F. Rossi (2010), *The flow of knowledge from the academic research base into the economy: the use and effectiveness of formal IPRs and "soft IP" in UK*, Report to the Strategy Advisory Board for Intellectual Property Policy (SABIP). <https://www.researchgate.net/publication/291838513>

³¹ Case extracted from: Nauwelaers, C. (2009), *Governance of Regional Innovation Policy: Variety, Role and Impact of Regional Agencies Addressing Innovation (RIAs)*, background paper for OECD (2011), *Regions and Innovation Policy*, OECD Publishing, Paris.

cases, the IDCs are in a position to deliver technical advice, but in most cases, the IDCs act as intermediaries, signposting relevant sources of knowledge in Sweden or abroad.

Innovation Clusters act as platforms for identifying partners, for exchanging ideas and deploying collective actions such as technology and market watch or joint internationalisation activities. They are in principle industry-driven, although in some cases this industry driving force might be weaker than expected. In many cases these clusters have as an explicit aim the development of collaborative research projects.

- **Wallonia's** competitive clusters³² are groupings of companies, training centres and public or private research units in the region, committed to a partnership-based approach intended to generate synergies in relation to common innovative projects. This partnership is structured around a market and the related technological and scientific field, and must achieve the critical mass needed for competitiveness and international visibility. These three main components (companies, training, research and innovation), brought together by the three priorities consisting in partnership, concrete common projects and international visibility, are the key elements of competitive clusters.

Innovation/knowledge/R&D voucher schemes for SMEs are very common instruments, found in almost all EU Member States and also in regional level innovation policy mixes. They are demand driven measures aimed at increasing SMEs collaboration with public research institutes. Vouchers, whose values are typically low (e.g. €5k) cover part of the costs of the purchase of knowledge from public research institutes for development projects. In a first generation, vouchers were mostly targeted at R&D activities and relationships between PROs and companies; later on, these were extended to cover more diversified innovation support services (OECD 2011)³³. Some of the schemes also work on a cross-border basis, allowing companies to use expertise outside of their country. This type of instrument has been promoted at EU level through the Riga declaration³⁴ which stated the following: 1) Innovation vouchers are demand-driven innovation support measures and should therefore be defined and implemented in a way that serves the practical needs of SMEs; 2) Innovation vouchers should support all forms of innovation; 3) The administrative costs of implementing innovation voucher schemes should be kept as low as possible; 4) Innovation vouchers should be subject of regular impact assessments; 5) Innovation vouchers should be implemented at local, regional and national level, thus fully taking into account the subsidiarity principle; 6) Innovation vouchers have the potential to raise the quality of innovation support to SMEs; and 7) The European Commission, Member States and regions are invited to consider the wider use or promotion of innovation vouchers.

- In 2008, Baden-Wuerttemberg was the first **German** Region to introduce an innovation voucher scheme for SMEs³⁵. The innovation vouchers allowed small enterprises (with fewer than 50 employees) to make use of R&D or market research services for product, service and process innovation. The scheme was extended to innovative high-tech start-ups in 2012. Since 2013, there has also been a Creative voucher for micro-enterprises and professionals of the cultural and creative industries. Each voucher has a value between €2,500 and €6,000 and can be used with public and private providers across Europe. The administration of the scheme is very light and quick. Interesting features of the use of this scheme are: 2/3 of vouchers are used with service providers from the

³² <http://clusters.wallonie.be/federateur-en/what-is-a-competitive-clusters.html?IDC=349>

³³ OECD (2011), *Regions and innovation policy*, OECD Publishing, Paris.

³⁴ European Commission (2010), *Riga declaration: Realising the full potential of innovation voucher programmes*, http://hytetra.eu/d/news/Riga_declaration.pdf

³⁵ Case extracted from Coletti, M. (2014), *Creative Industries Innovation Vouchers*, European Creative Industries Alliance. <http://eciaplatform.eu/wp-content/uploads/2014/06/Thematic-paper-Innovation-vouchers-Milan.pdf>

private sector, often engineering companies, while 1/3 are used with public R&D institutions; less than 10% of the vouchers are used outside of the region.

Support schemes for hiring researchers in companies and placement schemes are implemented in a variety of modalities. Their aim is to bring academic knowledge to companies, embodied in (young) graduates or involving students. The goal of these schemes is twofold: to upgrade research and innovation capacities in companies, and to create and maintain linkages between academia and industry.

- A well-known example of such a scheme is the long-standing Knowledge Transfer Partnerships (KTP)³⁶ Programme in the **United Kingdom** (formerly Teaching Company Scheme). This programme supports the placement of a graduate in a company, responding to the research and innovation needs of the company and at the same time facilitating access to knowledge resources in the public research sector. A 2010 evaluation³⁷ of the scheme points to a high degree of satisfaction both from the side of academia, which gains new insights for teaching and for the identification of new research themes thanks to the connection with industry, and from the side of businesses. A more recent evaluation (2015)³⁸ of the scheme in Scotland is also highly positive and notes that businesses invest additional money, besides the agreed co-funding, to further exploit the results of KTP projects. It concludes that successful, innovative collaboration relies on two factors: 1) the strength of the relationship between the partners; and 2) the absorptive capacity of the business partner.
- Graduate Opportunities Wales³⁹ is a funding programme of the government of the **Wales** region that aims to foster graduate employability and skills and to enable SMEs and other organisations to access higher level skills, knowledge and innovative potential. It supports a diversity of activities: work placements (10-week paid placements) and work tasters (10-day placements) of students and graduates in Welsh companies; financial support for training of graduates within Welsh businesses; a Graduate Academy – an opportunity for graduates to develop work readiness skills; a Freelancer Academy (introductory training for graduates exploring a freelancing career; and a job advertisement website. The interim evaluation of the scheme states that (DTZ 2011): “*early assessment of impact is very positive for both students/graduates and employers*”, including “*strongly positive impacts on employer attitudes to graduate recruitment in the future, the likelihood of further engagement with universities and the likelihood of further training of staff in the future*”.

3.3. Instruments targeting the interface between the public research sector and industry

PPP complex programmes (centres or networks)⁴⁰

Establishing physical or virtual research centres that gather partners from the private and public sectors is a direct way of addressing the ‘science-industry divide’. In these joint structures, researchers from universities, PROs and companies work together on research, development and innovation projects that fit their individual and collective

³⁶ <https://www.gov.uk/guidance/knowledge-transfer-partnerships-what-they-are-and-how-to-apply>

³⁷ Regeneris Consulting (2010), *Knowledge Transfer Partnerships Strategic Review*, Technology Strategy Board. <http://www.innovation-policy.org.uk/compendium/reference/Default.aspx?referenceid=643>

³⁸ EKOS (2015), *Impact Evaluation: Knowledge Transfer Partnership Programme in Scotland*, Report for the Scottish Funding Council.

³⁹ DTZ (2011), *Interim Evaluation of the GO Wales Programme*, Final Report to Higher Education Funding Council for Wales. <http://gov.wales/funding/eu-funds/previous/project-evaluations/go-wales/?lang=en>

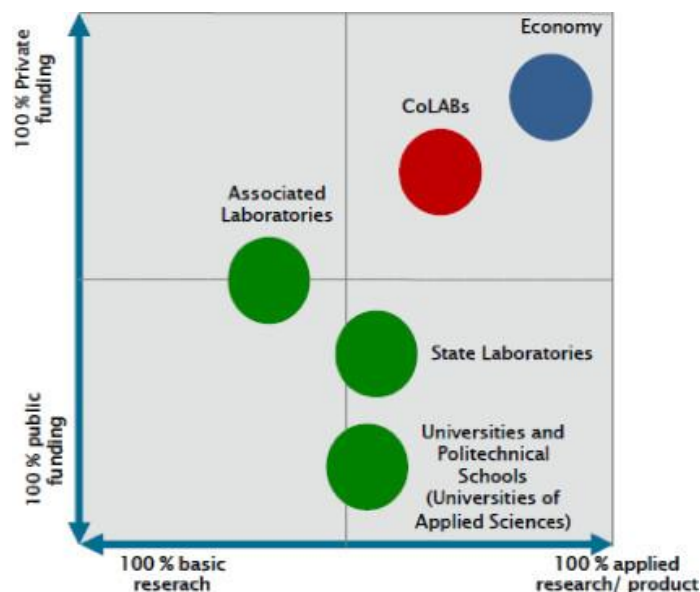
⁴⁰ As mentioned above, this instrument was covered in another MLE on the evaluation of complex PPP programmes: <https://rio.jrc.ec.europa.eu/en/policy-support-facility/mle-evaluation-complex-ppp-programmes-sti>.

strategies and benefit both types of partners. Thanks to their size, and due to their structural character, 'PPP complex programmes' have the potential to influence the direction of technology and innovation efforts in a national context in a significant and durable way. These programmes and centres are typically selected through a competitive process, funded by public and private money, and are expected to bid for additional funding from competitive sources of national and international origin. They are established with a long-term perspective, are subject to regular evaluations (which impact on further funding) and are expected to become less (or even non-) reliant on public funding over time. These programmes stand in between pure structural funding programmes and project funding programmes (see below).

'PPP complex programmes' often take the shape of competence centre programmes. These have a long history and the earlier models found in Canada and Sweden (in 1993) inspired subsequent initiatives in many EU countries. Competence centres were established, e.g. in Austria in 1998 (K-plus, and later K-net and K-ind programmes, followed in 2008 by the COMET programme), and were seen as a radical innovation and a success story in this country⁴¹. These centres are either established as distinct legal entities or are integrated into universities. New Member States have adopted the model in more recent years, e.g. in Estonia as early as 2003, while the newest Member State, Croatia, finalised the selection of its competence centres at the beginning of 2018.

- Within a context of shifting policy towards support for intermediary organisations, **Portugal** has established CoLABs as public-private research partnerships acting as intermediaries between HEIs/PROs and businesses (Figure 1). Private funding accounts at least for 50% of the CoLABs budget, and public funding is devoted to the creation of PhD positions and highly skilled jobs.

Figure 1. CoLABs as intermediaries between science and industry in Portugal



Source: OECD (2017)⁴²

- In line with its commitment to generating economic value from publicly-funded research, the **Irish** Government provides funding to establish 14 industry-led Technology Centres⁴³. These centres are collaborative entities established and led

⁴¹ Biegelbauer, P. (2007), Learning from abroad: the Austrian competence centre programme Kplus, *Science and Public Policy*, 34(9), November, pages 606-618.

⁴² OECD (2017), *Stimulating knowledge transfer: Challenges and policy responses*, Workshop summary, Lisbon 7-8 November. <https://www.innovationpolicyplatform.org/Lisbonworkshop2017>

⁴³ <https://www.enterprise-ireland.com/en/Research-Innovation/Companies/Collaborate-with-companies-research-institutes/Technology-Centres.html>

by industry, aiming at introducing companies to the research expertise in Irish Higher Education Institutes. The Technology Centres are resourced by highly qualified researchers associated with research institutions who are empowered to undertake market focussed strategic R&D for the benefit of industry. Technology Centres whether hosted in a University or not have support from partner colleges to deliver on the research needs of the companies.

Science and technology parks are infrastructures aimed at stimulating the growth of high tech employment and at encouraging the transfer of technology from universities and other research organisations. Their main characteristic is the co-location of PROs and/or HEIs on the one hand, and companies on the other hand, at the same place. Proximity is seen as a favouring factor for exchanges of knowledge and the establishment of all types of cooperative initiatives based on the joint exploitation of expertise present in the various organisations. Science and Technology Park models differ according to several features (Nauwelaers et al. 2014)⁴⁴, namely: 1) Priority placed on property management or on a wide range of professionalised 'soft' business support services; 2) Priority placed on the commercial viability of the property, versus premium on high technology and potential for knowledge exchange with tenants; 3) Priority placed on connection to global actors versus the embedding of key regional players in regional innovation ecosystem; 4) Presence or absence of a top level research institution or university at the core of the STP and level of intensity of third mission activities by public research institutions; 5) Central or marginal role played in terms of the support of knowledge-intensive development in the surrounding territory.

- The **Finnish** Joensuu Science Park⁴⁵ is located in the easternmost province in North Karelia. Three higher education institutions are based in the Science Park. The main regional industry sectors are metal, wood and forestry. The Joensuu Science Park was established in 1990 and is part of the Finnish Centre of Expertise programme. It has specialised expertise in nanotechnology, future forestry industry, building technology and energy technology. The main goal is to promote the commercialisation and use of research and new information in the business operations of companies. The Science Park provides expert services support to companies in planning, developing, executing and monitoring strategy-based development programmes. To this end, it offers an integrated package of services covering all aspects of innovation. Due to its central position in the knowledge-intensive economy of the region, the Science Park acts as an orchestrator of regional resources for the definition of a joint vision concerning growth choices and the principles behind them. Thanks to their involvement in the definition of a joint vision and the elaboration of the regional S3 strategy, the organisations involved in the platform created by the Science Park are committed to the choices made and the implementation of the measures.

Funding programmes for collaborative research projects, involving research performers from the public and private sectors, are policy instruments in widespread use all over Europe. In contrast to the above-mentioned clusters or PPP complex programmes, these programmes fund projects on an individual basis and for a short period (typically for a duration of 1 to 3 years), rather than longer-term structural research and innovation partnerships. In common with these other two instruments, they require that actors from both the private and public research sectors join forces in the implementation of projects. Beyond variation in the size, duration and implementation modes of these programmes, an important difference exists between programmes that are generic (which fund projects in any field, technology or activity domains) and those that are thematic (which are typically restricted to specific fields, technology or activity domains). With the new waves of regional smart specialisation strategies adopted across

⁴⁴ Nauwelaers, C., A. Kleibrink and K. Stancova (2014), The Role of Science Parks in Smart Specialisation Strategies, *S3 Policy Brief Series* n° 08/2014. <http://s3platform.jrc.ec.europa.eu/-/the-role-of-science-parks-in-smart-specialisation-strategies?inheritRedirect=true>

⁴⁵ Case extracted from Nauwelaers et al. 2014.

the EU, the expectation is that the share of thematic funding programmes, focusing on priority domains, will increase (thematic innovation funding instruments grew in importance over the period 1999-2012, see section 3.1).

- The **Irish** Innovation Partnership programme⁴⁶ provides funding to consortia formed of companies who engage in collaborative research projects with Irish universities and Institutes of Technology. The grants managed by Enterprise Ireland under this programme can cover up to 80% of the cost of research work to develop new and improved products, processes or services, or generate new knowledge and know-how. The duration of the collaborative research is from six months up to a maximum of two years. Full-scale applications are scanned for technical and commercial feasibility and submitted for approval to the Industry Research and Commercialisation Committee, chaired by Enterprise Ireland's Director of Science & Innovation and including members drawn from academia and industry.

Lessons learned with respect to design, implementation and success factors for collaborative research programmes are covered in more detail in Section 4.4 below.

Industrial PhD schemes contribute to the goal of fostering academic-business research collaboration like the above collaborative research programmes, but an important additional feature is the presence of researchers that spend at least part of their time working in an industrial setting, thus maintaining a link between the two sides. The scheme acts as a training period for the researchers, who have the dual objective of finishing their PhD degrees and working within a company on research projects oriented towards business development. The scheme targets PhD candidates but can also be extended to young post-docs in order to carry the thesis results to the market within a company: the scheme from the European Institute of Technology, EIT Digital, targets this group.

- The **Flemish** Baekeland⁴⁷ grants are awarded to PhD candidates for a period of four years, allowing them to spend part of their time in a company while being enrolled at a university. The company determines the strategic orientation of the research and provides co-funding. The subsidy amounts to 50% to 80% of the personnel and operational costs for the PhD candidate.
- EIT Digital⁴⁸, a Knowledge and Innovation Community of the **European** Institute of Innovation and Technology, offers Industrial Doctorates positions. Under this scheme, PhD students work under academic supervision on research assignments from industry and benefit from continuous tutoring from this industry. The French government has embraced EIT Digital's Industrial Doctorate by signing a cooperation agreement: in this CIFRE-EIT Digital arrangement, companies that hire PhD-candidates to do research receive extra financial support.

Lessons learned with respect to design, implementation and success factors for Industrial PhD schemes are covered in more detail in Section 4.3 below.

Sectoral mobility schemes for researchers promote the hiring of researchers between public research and companies in one or both directions, with the aim to exploit the complementary skills and competences of both types of organisations, upgrade innovative capacity in firms and introduce better understanding of industry in academia.

⁴⁶ <https://enterprise-ireland.com/en/Funding-Supports/Company/Establish-SME-Funding/Innovation-Partnerships.html>

⁴⁷ <https://www.vlaio.be/nl/subsidies-financiering/baekeland-mandaten>

⁴⁸ <https://www.eitdigital.eu/eit-digital-academy/doctoral-school/>

- The **EU** Research and Innovation Staff Exchange (RISE⁴⁹) scheme promotes international and cross-sector collaboration through exchanging research and innovation staff and the sharing knowledge and ideas between public research and economic actors. RISE involves organisations from the academic and non-academic sectors (in particular SMEs). Support is provided for the development of partnerships in the form of a joint research and innovation project. This is aimed at knowledge sharing via international as well as intersectoral mobility, based on secondments of research and innovation staff (exchanges) with an in-built return mechanism. The organisations constituting the partnership contribute directly to the implementation of a joint research and innovation project by seconding and/or hosting eligible staff members.

A study⁵⁰ on sector mobility of senior researchers between academia and businesses has been conducted in 2016, covering cases in Germany, Denmark and Switzerland. The study highlights that this type of mobility is rare, while the potential effects on science-industry relationships are large, due to the high level of expertise and important network connections held by mobile senior researchers or professors (see Table 2).

Table 2. Effects of the sectoral mobility of senior researchers on academia and business

<p>Effects in academia</p> <ul style="list-style-type: none"> ➤ Higher degree of industry and application-oriented research focus and topics. ➤ Strengthened competences regarding attraction of external funding. ➤ Stronger network and door-openers to collaborative partners in the business sector. ➤ More result and relevance oriented culture and work practices. ➤ Advancement in research careers and managerial responsibility. ➤ More relevance and practical orientation of educational activities. ➤ Role models for students, PhDs, and young researchers, motivating (and even helping) them to pursue a career in industry or starting new businesses. <p>Effects in businesses</p> <ul style="list-style-type: none"> ➤ Easier and more direct access to a university talent pool at both Master's and PhD-level. ➤ Better and less complicated matchmaking with researchers at the university in question, as well as with environments at other universities. ➤ Increases in other forms of knowledge collaboration, especially joint R&D-projects and student projects. ➤ Access to cutting-edge research results crucial for innovation in the company, especially with regards to industry 4.0-related research. ➤ More long-term and stable relations to the research environment, making research-collaboration more long-term and forward thinking.

Source: IRIS group and Lauritzen consulting (2016)

The involvement of businesses and HEIs/PROs in national/regional innovation strategies and platforms has recently been given a boost thanks to the obligation all European regions now have to develop smart specialisation strategies as a pre-condition for accessing ESIF during the period 2014-2020. Many universities have expanded their role in governance structures and advisory bodies in their regions as a way of reinforcing their contribution to economic and societal development.

- Luleå University of Technology (LTU)⁵¹ in **Sweden** plays an active role in regional development. This includes participation in projects funded by ESIF. More

⁴⁹ <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/msca-rise-2018.html>

⁵⁰ IRISgroup and Lauritzen consulting (2016), *Analysis of sector mobility – effects, drivers, and good practices in Denmark, Germany, and Switzerland*, report to the Danish Council of Research and Innovation Policy.

⁵¹ <https://www.ltu.se>

importantly, LTU maintains a close dialogue with regional players and stakeholders regarding the development of the region, through several fora. The university has a bilateral agreement with the Region of Norrbotten concerning discussions on how best to combine forces in order to develop the region. Regional representatives, alongside some of the managing authorities and universities in Norrbotten and Västerbotten, participate in dialogue meetings arranged by the North Sweden European Office, a forum aimed at creating a link between the region and the EU in relation to research and innovation as well as EU cohesion policy. Europaforum Northern Sweden brings together regional representatives and municipality representatives in the four northernmost counties of Sweden with the aim of joining forces to position this part of Europe in the political arena. Outputs from this collaboration include position papers that elaborate joint messages concerning regional priorities.

The engagement of industry in HEIs/PROs takes various complementary forms:

- Formal membership of industry at institutional level, with industry delegates in HEIs/PROs Boards or other governing bodies;
- Consultation with companies during the development of HEI/PRO strategies;
- Signature of formal agreements to participate in public-private strategic research partnerships (see above PPP complex programmes, section 3.3).

All these forms are complementary to the engagement of industry at faculty or research laboratory level, through endowments from industry in the form of 'Chairs' and the development of more informal regular collaboration channels through contract research or collaborative research under one of the above-mentioned schemes.

- In **Hungary**⁵², the Széchenyi István University, in association with Audi Hungary, has developed a multilevel partnership which has led to the creation of the Audi Hungary faculty of Automotive Engineering within the university. The main aim behind the development of the faculty is the provision of education and applied research programmes targeted at strengthening and further developing the skills and expertise available in the region to support the expansion and development of its automotive industry. Audi Hungary has provided investment through the provision of direct finance, equipment and expertise. The university has prioritised the development of the faculty in terms of staff deployment and infrastructure development. Both partners have seen benefits accrue from the partnership with, for example, the university students gaining invaluable experience and exposure to cutting edge automotive technology and training and Audi Hungary being able to access academic expertise within the University to assist in the development of new technologies relevant to their industry.
- In **Spain** a university-industry chair is an agreement between the two parties, for a minimum of three years, to work together on a selected topic. It includes an economic commitment from the enterprise. However there is no creation of a new 'chair' as individual, like it is the case in other countries.

⁵² Case extracted from OECD (2017), *Supporting Entrepreneurship and Innovation in Higher Education in Hungary*, OECD Publishing, Paris.

4. Lessons

4.1. Lessons on policy mixes for science-business cooperation

As mentioned in the introduction of this report, the goal of encouraging science-business cooperation is broader than just organising technology transfer from science to industry; hence a comprehensive set of instruments is needed to reach that central goal for research and innovation systems. This section addresses the question of **how to ensure a coherent, balanced and effective policy mix** of instruments within the landscape of section 3, i.e. a portfolio of instruments that is tailored to the specific needs and potential of the national/regional research and innovation system, and that effectively bridges the gap between science and industry.

The **'policy mix' idea** is that it is the combination and interaction between a large variety of instruments that ultimately will impact on research and innovation systems: it would be wrong to base decisions on a simplistic 'one problem-one instrument' picture (Nauwelaers et al. 2009)⁵³. The challenge at stake is to define an appropriate combination of instruments which together address gaps and potential in a system, taking into account intended and unintended interactions between the various instruments. Beyond the choice of a relevant portfolio of instruments, it is also necessary to take good care of implementation details of these instruments, since the effectiveness of the portfolio as a whole depends on the actual results and impacts achieved by each instrument: for example, competence centres can in practice be industry-driven or research-driven, be physical or virtual centres, and their impact on a research or innovation system will differ accordingly. Lastly, it should be noted that even a well-balanced and effective policy mix cannot compensate for weaknesses in framework conditions for innovation (e.g. economic specialisation in low-tech sectors, lack of large and research-intensive firms, weak entrepreneurial spirit, low education standards and achievements, poor infrastructure, etc.).

To start with, **an effective policy mix for science-business cooperation should address, in a balanced way, three typical problems** faced by many countries in Europe:

- The weak orientation of the public research sector to the needs of industry and society at large (i.e. the upper part of the 'landscape' in Table 1 of section 3);
- The insufficient involvement of businesses in R&D and innovation activities and consequent lack of demand for public research results (i.e. the middle part of the 'landscape' in Table 1 of section 3).
- The gap between the public research and business sectors (i.e. the lower part of the 'landscape' in Table 1 of section 3).

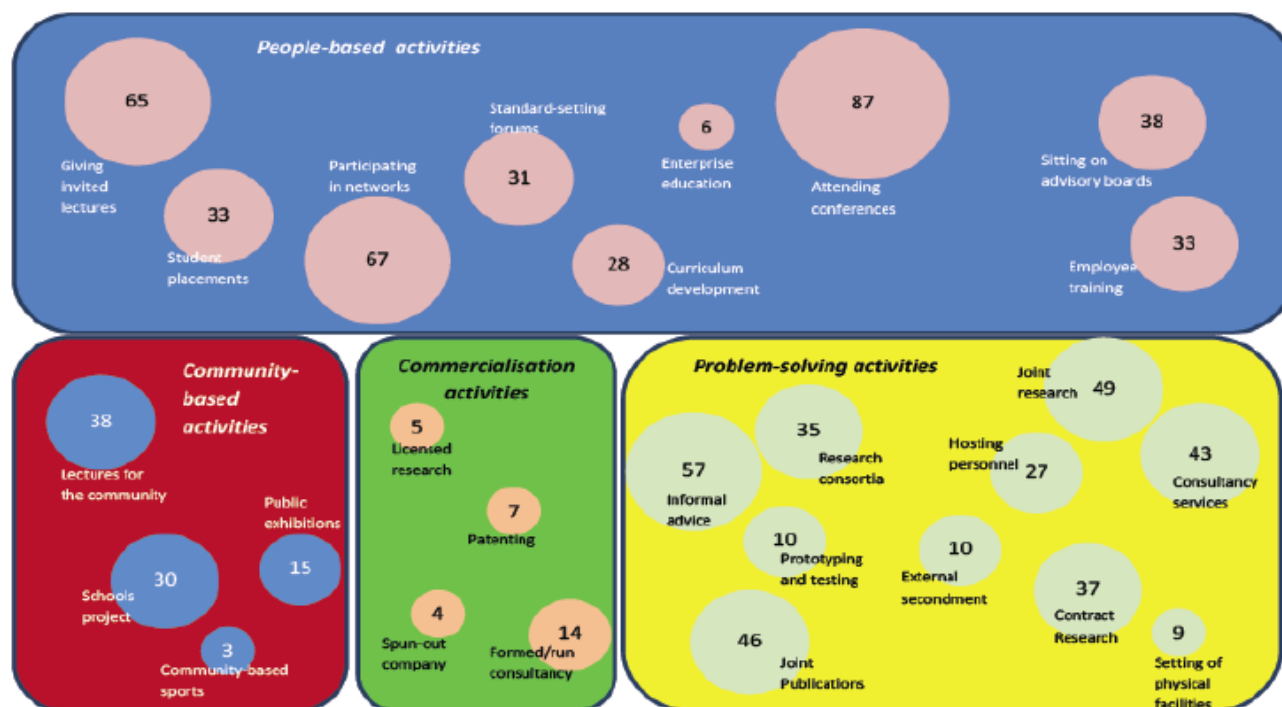
The balance of instruments should also be **adapted to the strength of science-business cooperation**. In countries with weak science-business cooperation, the policy mix would need to give more prominence to those instruments aimed at initiating such cooperative linkages, e.g. innovation vouchers or strengthening the role of innovation support services. In countries with stronger science-business links, formal mechanisms such as complex PPPs may receive more priority.

⁵³ Nauwelaers, C., P. Boekholt, B. Mostert, P. Cunningham, K. Guy, R. Hofer, C. Rammer, (2009), *Policy Mix for R&D in Europe*, Report for DG Research, April. <https://publications.europa.eu/en/publication-detail/-/publication/b3a5d015-05aa-45f0-95c0-c03535fca99f/language-en/format-PDF/source-68821682>

A key message is that a **good policy mix has to embrace the variety of types of interactions that can take place between the public research sector and the economy**. This also includes efforts to promote cooperation between science and industry at the international level.

An overview of studies on the strategic role of universities in stimulating innovation and economic growth highlights that research commercialisation paths are only a small part of the spectrum of possible interactions (Hughes and Kitson 2012)⁵⁴. According to their enquiry in the UK, commercialisation activities by HEIs are only a small part of the picture (Figure 2).

Figure 2. Impact Pathways of UK Academics (% of academics reporting the interaction with an external organisation)

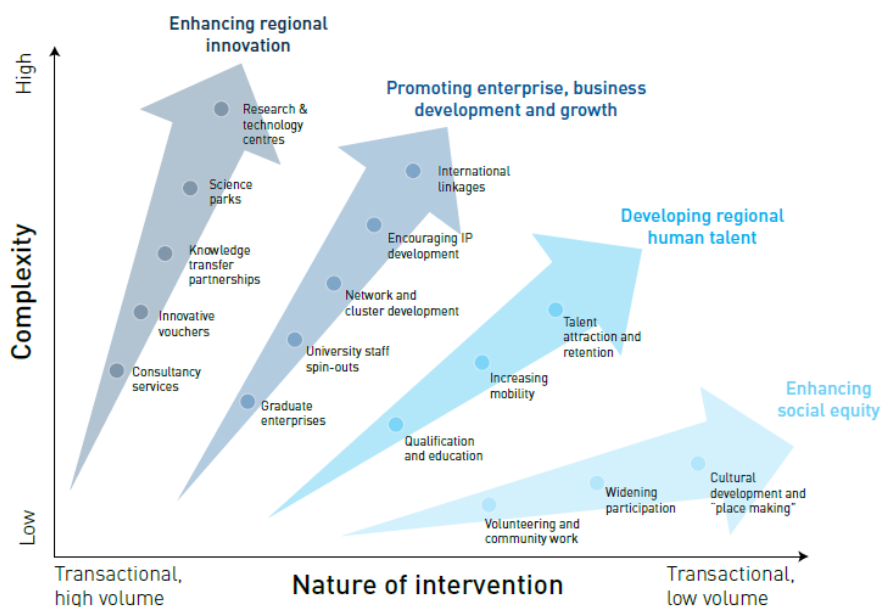


Source: Hughes and Kitson 2012

With Smart Specialisation Strategies at play in EU regions and countries, HEIs have got an additional motivation to take part in the development of regional innovation strategies and contribute to the entrepreneurial discovery process, entering into knowledge co-creation together with the private sector. Hence the policy mix needs to go much beyond instruments promoting technology transfer only. As indicated in Figure 3, **the contribution of HEIs to economic development goes well beyond classical research commercialisation or technology transfer activities**: it also encompasses direct services to the economy through consultancy or services activities, the participation in public-private endeavours such as networks and clusters, the development of human talent able to nurture the economic sector, and wider societal engagement actions. **Enduring partnerships require a rich set of aligned instruments during long periods of time.**

⁵⁴ Hughes, A and M. Kitson (2012), Pathways to impact and the strategic role of universities, Centre for Business Research, *University of Cambridge Working Paper* No. 435. <https://michaelkitson.files.wordpress.com/2013/02/hughes-and-kitson-cbr-2012.pdf>

Figure 3. The variety of interactions between HEIs and innovation ecosystems⁵⁵



Source: P. Haring Bolívar, 'Fostering regional competitiveness – why and how to build up enduring partnerships?', EUA Annual Conference, Antwerp, 16-17 April 2015, based on: European Commission, 'Connecting Universities to Regional Growth: A Practical Guide', September 2011

To explore all these dimensions in practice, HEInnovate⁵⁶, a joint initiative by the European Commission (EC) and the OECD, offers a guiding framework that provides inspiration and assistance for governments and HEIs to stimulate innovation and entrepreneurship. It includes an online self-assessment tool covering **seven dimensions of the innovative and entrepreneurial HEI**:

- Leadership and Governance;
- Organisational Capacity: Funding, People and Incentives;
- Entrepreneurial Teaching and Learning;
- Preparing and Supporting Entrepreneurs;
- Knowledge Exchange and Collaboration;
- The Internationalised Institution;
- Measuring Impact.

A review⁵⁷ of innovation policy trends during the period 1999-2012 noted that policy mixes had been stable over the 1999-2012 period, and even more so in countries at the top of the innovation league, which have more mature policy systems. The review criticises the homogeneity and similarity of policy mixes across countries with different needs and potential: there is no policy mix that is in essence superior to another, but **the range of instruments in a policy mix should be adapted to country conditions**. In particular, the capacity of the business sector to enter into cooperative partnerships with the science sector is predicated on companies' absorptive capacity for research results and technology developments. Too much pressure on universities (in particular at regional level) to cooperate with SMEs lacking a minimum set of capabilities for research can even produce a boomerang effect by reducing their interest for this type of

⁵⁵ Cited in: European University Association (2018), *Coherent policies for Europe beyond 2020: maximising the effectiveness of smart specialisation strategies for regional development*. <http://www.eua.eu/Libraries/publications-homepage-list/coherent-policies-for-europe-beyond-2020-maximising-the-effectiveness-of-smart-specialisation-strategies-for-regional-development>

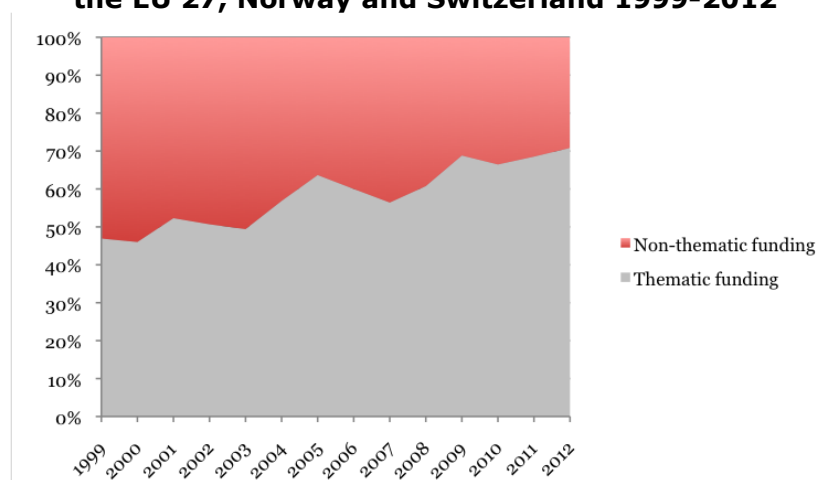
⁵⁶ www.heinnovate.eu

⁵⁷ Kincső, I., P. Markianidou and S. Radošević (2013), *Lessons from a Decade of Innovation Policy: What can be learnt from the INNO Policy TrendChart and The Innovation Union Scoreboard*, European Commission, DG Enterprise and Industry.

cooperation in the future. The review identified three important trends in the policy mixes over the period:

1. An increase in importance of dedicated programmes (both in terms of funding and number of measures) compared to institutional funding (even if the latter still constituted a large share of public money invested in research and innovation). This reflected governments' growing willingness to steer, rather than to just fund research and innovation systems;
2. A shift towards collaborative schemes, at the expense of support for individual organisations;
3. The growing importance of thematic funding programmes versus generic programmes (Figure 4).

Figure 4. Evolution of thematic funding (only grants) in terms of total budget in the EU 27, Norway and Switzerland 1999-2012



Source: Kincsö et al. (2013)

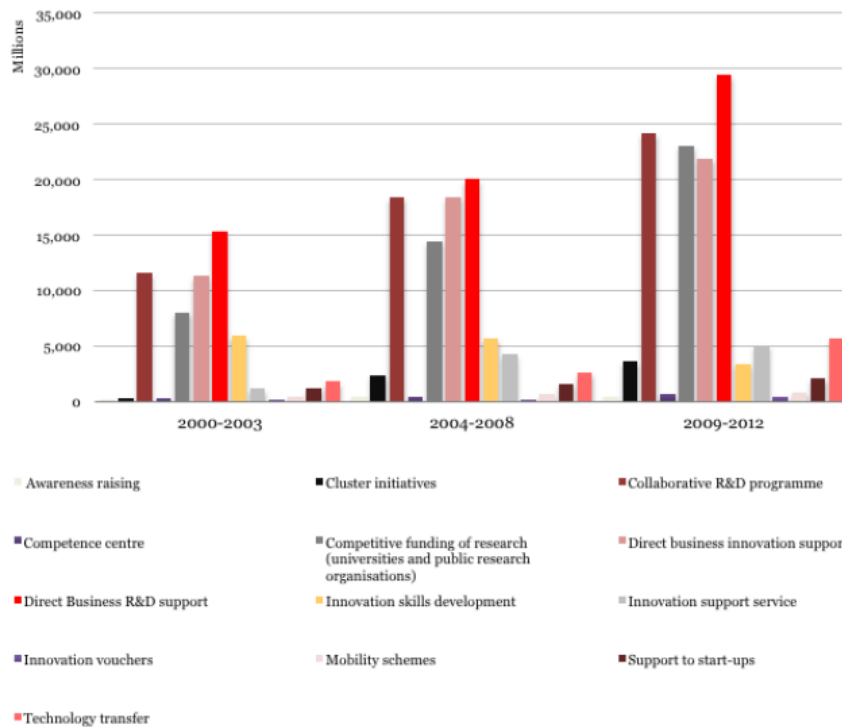
With respect to the first point above, the review found that **three types of instruments dominated the innovation policy mixes** (in terms of amounts of public money invested in policy measures, excluding institutional funding): 1) direct support to business R&D and business innovation through grants and loans; 2) collaborative research programmes and 3) competitive funding programmes for HEIs and PROs (Figure 5). The amount of funding devoted to those instruments had been steadily growing over the period, with the exception of a decrease in collaborative programmes in the aftermath of the 2008 crisis. Funding devoted to the other instruments included in the landscape of section 3 (Table 1) (clusters, competence centres, innovation vouchers, innovation support services, technology transfer mechanisms, mobility schemes) represented a much smaller share of the policy mix, but had been increasing too⁵⁸.

For each EU country, the review compared the intensity of science-industry collaboration (using as a proxy the CIS indicator 'share of firms collaborating with public institutions') against the presence of relevant policies (measured by the share of measures devoted to the promotion of industry-science collaboration in the overall innovation policy portfolio). Using different analytical methods, the review found a (weak) positive correlation between the two measures – though less clear for countries with the highest collaboration patterns (Figure 6). The authors were careful not to infer a causal relationship between the two measures: as mentioned above, other elements such as university and IPR rules, vitality of entrepreneurship, match between research strengths

⁵⁸ The only type of instrument for which public funding decreases over the period is the 'innovation skills development' scheme.

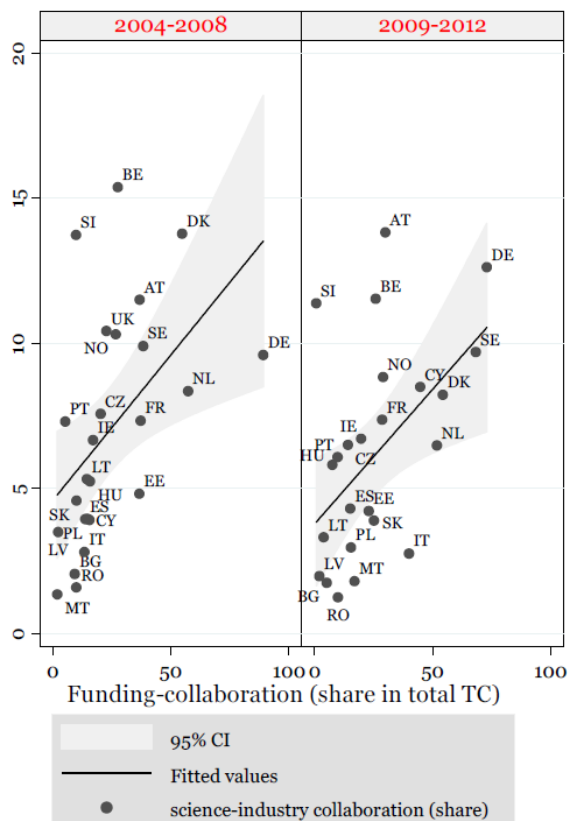
and industrial specialisation, etc. are also important determinants of the intensity of science-industry relationships at country level.

Figure 5. Composition of research and innovation policy funding in EU 27, Norway and Switzerland 1999-2012



Source: Kincso et al. (2013)

Figure 6. Share of Trendchart funding allocated to science-industry collaboration and share of firms collaborating with science



Source: Kincso et al. (2013). Note: Finland excluded as it is an outlier.

Lessons learned from this review, which are useful for this MLE, are the following:

- There is an overall **positive linkage between funding devoted to policy instruments aimed at fostering science-industry links and the strengths of these links**;
- In more innovative countries, the impact of policy instruments might be weaker because of a tendency to cooperate at an international scale. Developing science-business cooperation at a national level is **complementary to the internationalisation strategies** of both science and business actors. In particular, if they are to act as useful partners for business, HEIs and PROs need to reinforce their level of participation in international knowledge networks.
- In less innovative countries, the problems are: weaker absorptive capacity in the business sector and the lack of business orientation of the public research sector, both of which need to be tackled as a prerequisite for the establishment of strong science-industry linkages. Implementing instruments aimed at fostering linkages between the science and the business sectors is an effective strategy only if those two sectors are sufficiently strong in research and innovation and open to cooperation. If this is not the case, the instruments targeting cooperation will not compensate for weaknesses on either or both sides. In other words, **implementing reforms on the science side and reinforcing research and innovation capacities on the business side are crucial too**, especially in countries that are modest or moderate innovators.

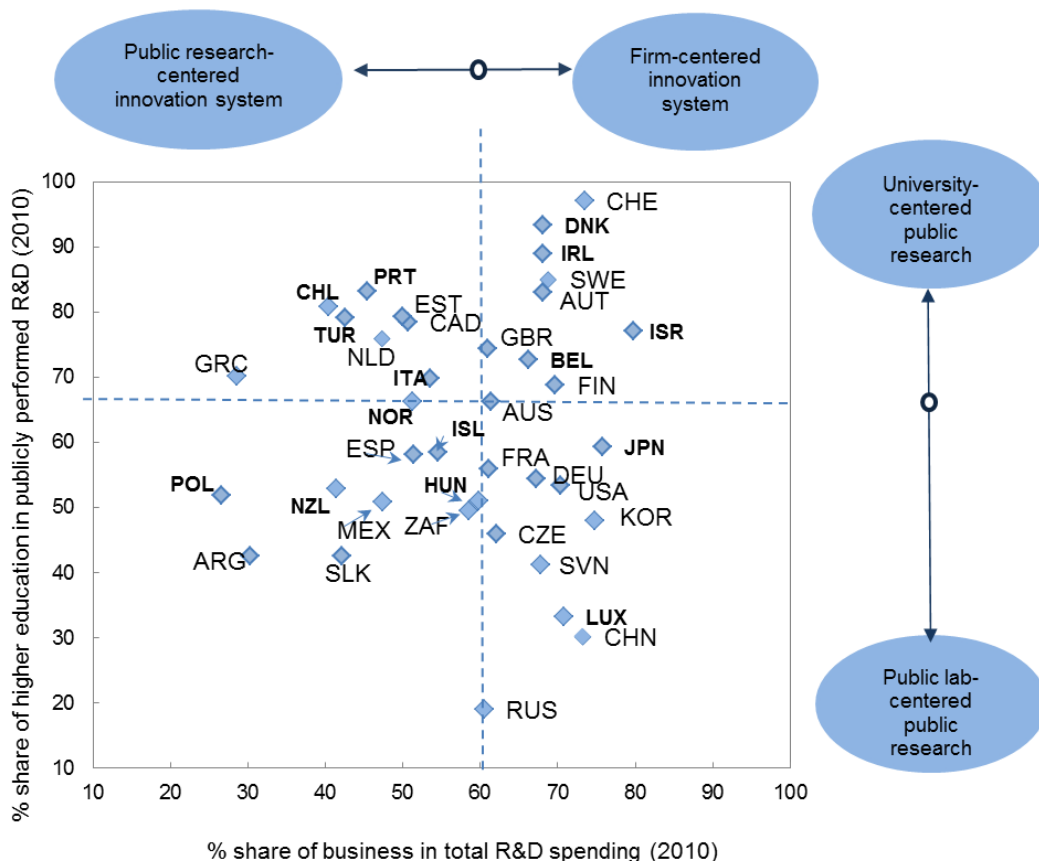
An important aspect of the context in which policy mixes for science-business cooperation have to operate is the nature and composition of the public research sector. OECD analyses claim that those countries with a large share of public research conducted in PROs are in a more favourable position with respect to science-industry cooperation than those with HEI-dominated systems (Figure 7). This is because PROs are more often oriented towards applied research than HEIs and more likely to integrate the development of linkages with industry in their mission. Hence policy mixes will differ according to the two situations, with an **enhanced need to introduce reforms and incentives for collaboration with businesses in HEI-dominated systems**. The latter is in particular the case in the EU15 where there is a strong legacy of separation between the academic sector and business. This is however not the case in those countries where HEIs have been reformed to integrate a third mission, such as Sweden and Ireland. More importantly, the need for reform is greater in public research-centred innovation systems than it is in firm-centred innovation systems. A key issue is whether there is an R&D oriented industrial base that is capable of working with HEIs and PROs with little familiarity with industrial R&D and innovation needs.

Because 'bridging science and industry' is a central objective within overall research and innovation policies, **general rules for effective innovation policies** are also relevant to the specific policy mix targeting the bridge:

- Achieving a relevant balance between bottom-up (research-driven) and top-down (mission-oriented, societal challenge-oriented) research;
- Streamlining programmes in order to reduce unnecessary duplication and achieve synergies;
- Reducing fragmentation in research through the creation of critical masses;
- Establishing or reinforcing institutional funding mechanisms that reward quality;
- Supporting both existing research and innovation actors as well as the renewal of research base;

- Adopting quick, effective, and non-bureaucratic mechanisms for project and initiative selection, based on relevant criteria;
- Increasing internationalisation of research and innovation activities.

Figure 7: Public versus private research and share of HEIs in public research in OECD countries



Source: OECD (2013)⁵⁹

4.2. Lessons on Technology Transfer Offices (TTOs)

A H2020-funded project, PROGRESS-TT60, gathered TTOs and experts throughout Europe with two aims. The first was to identify main barriers to successful technology transfer for TTOs. The following were identified: “*lack of general management training and IP management training and skills within the TTO, poor research quality at the PRO, leading to low opportunity of creating IP, or lack of incentive programmes implemented through TTO to engage researchers in technology transfer*”. Second, the project aimed at highlighting ‘best practices’ for TTOs. These practices were grouped under 4 areas on the project website:

1. Scouting ideas and technologies and incentivising disclosures;
2. Assessing IP potential, validating technologies and incentivising for commercialisation;
3. Accessing finance and interacting with financial stakeholders;

⁵⁹ OECD (2013), *Commercialising Public Research: New Trends and Strategies*, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264193321-en>.

⁶⁰ <http://www.progresstt.eu/best-practice-library/>

4. Securing staff skills and organising the TTO for growth.

An FP7 project, Entente⁶¹, aimed at reinforcing knowledge transfer offices in universities, public research organisations, hospitals and at promoting industry academia transnational collaboration in the health sector. It also created a repository of Best Practices, focusing on the enabling skills required in the technology transfer process, such as IPR management, drafting agreements, technology valuation and ethical considerations, and on how to practically implement these skills within academic TTOs. The three key recommendations of the project were:

- to prioritise technology transfer as a primary objective of academic health research (different mechanisms for incentivising research groups and researchers are proposed);
- to enhance investment in capacity building and professionalisation of academic TTO services. This can be done notably through staff exchanges between TTOs. One important aspect is the acquisition of knowledge on markets and needs and priorities of industry and investors. Training should be delivered by professionals with strong technology transfer track records (entrepreneurship, finance, venture capital, business development);
- to increase the availability of funding for feasibility/proof of concept work (since results of academic research often lack the level of robustness and validation required by industry when making an investment decision). TTOs should develop the capacity to (i) assist in the conception and execution of proof of concept work and (ii) monitor that this funding dedicated to valorising research is well spent (and for instance not derived to other research aspects of a more academic nature).

An interesting insight of the above project was that research findings of a non-commercial nature often remain unexploited despite their societal relevance (e.g. nutritional recommendations). Hence there is a role for research institutes and their TTOs to explore how they can assist their researchers in the implementation of so-called '**non-commercial**' research results.

The need for **professionalisation of TTO staff** is a recurrent issue: however there is a vicious circle at play for those TTOs that do not generate enough revenues from royalties and are unable to secure funding for training of staff.

An OECD analysis⁶² also concludes that revenues generated from patents and licenses at HEIs by universities are often overstated since only a few universities are successful in commercialising patented inventions and income from licensing is small compared to other external revenues such as contract research or consultancy services. TTOs do not generate positive net returns from patenting and licensing and have **diversified their services beyond IP management *stricto sensu***. New missions include: scouting activities for research results with commercial potential, support activities for collaborative research, administration of proof-of-concept and seed funds.

This **broadening of functions** also justifies a change in name, from Technology Transfer Offices (TTOs) to Knowledge Transfer Offices (KTOs), a term that is now commonly used in Europe.

The EU association of KTOs, ASTP-Proton⁶³, gathers technology transfer professionals across Europe and undertakes activities to respond to common challenges faced by these organisations and to represent them at EU level. It organises events, trainings, surveys,

⁶¹ https://cordis.europa.eu/result/rcn/177328_en.html

⁶² OECD (2013), *Commercialising public research, new trends and strategies*, OECD Publishing, Paris.

⁶³ <https://www.astp-proton.eu>

study tours, peer reviews and delivers accreditation of technology transfer professionals. It also monitors the activities of KTOs using the following indicators:

- Intellectual Property (IP) metrics: invention disclosures, patent applications, patents granted, active patent families;
- Contracts and licence income metrics: contract research agreements, collaboration agreements, consultancy agreements, licence agreements, software licence agreements;
- Spin-off metrics: number of new spin-offs.

Data collected by ASTP-Proton on a significant sample of European KTOs confirm that the **activity of KTOs is highly skewed**, with a few KTOs being responsible for large amounts of patents, contracts and license income and spin-offs creation. Regarding spin-offs: in 2015 48% of KTOs reported no spin-off creation; 17% reported only one; and only 7% reported more than 6 spin-offs for that year. The amounts of cashed-in equity were negligible for the vast majority (88%) of KTOs.⁶⁴

Patenting activity as a measure of KTO activity and of strength of academia-business relationship is difficult to interpret since:

- Patenting is less frequent in some fields (arts, humanities, social science) than in other fields (engineering, technology);
- Low patenting can reflect the situation of some HEIs/PROs, notably those that are strongly involved in contract research with external organisations that are, or could feasibly be, the IP rights holders;
- In countries where there is a 'professor privilege', patents are not recorded at the level of the PRO/HEI;
- Other IP protection modes may be used (design, utility model). Royalties can come from software licenses rather than from patents;
- Some KTOs follow a strategy of filing many patents and then abandoning the process if no commercial partner has been identified: this helps to explain a large discrepancy between patents filed and granted;
- On average, 21% of the patents held by KTOs are licensed or optioned, hence many patents do not lead to commercial exploitation.

One problem for TTOs is the **fragmentation of their activities** on a national basis: it is often the case that countries host a large number of independent TTOs of an individual size that does not allow them to acquire the broad range of skills necessary to carry out their mission, to specialise and to access to the networks of business and other partners. This has led to policy initiatives that attempt to create synergies between activities at a national level:

- Within its 'Investments for the Future' programme, **France** has created 14 'Technology Transfer Accelerator Offices' (SATTs)⁶⁵ that involve 590 professionals in intellectual property, technological engineering, law, marketing and business development. The SATTs, which are spread over the national territory and are shared by several HEIs/PROs, are dedicated to technology transfer and the maturation of inventions from these research units. They have been set up based on a competitive procedure. They aim to reduce the fragmentation of TTOs

⁶⁴ ASTP-Proton Survey Report FY2015. <https://www.astp-proton.eu/resource-center/publications/#download>

⁶⁵ <https://www.satt.fr/>

through joint actions (e.g. a common database of technologies ready to be transferred); to professionalise their activities through the sharing of methods and good practices; and to increase their visibility.

This issue of fragmentation has led to debates concerning the **choice of the best design model** for TTOs:

- Comprehensive or specialised;
- Exclusive or shared between various PROs/HEIs.

4.3. Lessons on Industrial PhDs

The success of Industrial PhDs can be measured along three dimensions:

- Increasing the employability of researchers in the private sector thanks to the acquisition of new and complementary skills;
- Upgrading firms' research and innovation capabilities;
- Improving university-business relationships and cooperation.

The **Danish** Industrial PhD-programme demonstrates **positive results on all these fronts**. This is a long-running programme promoting PhDs with industrial involvement in the EU. It started in 1989 and is still in place today. Currently the programme is funded by the Danish Innovation Fund. Industrial PhD candidates are hired by a company and enrolled in a university at the same time. Industrial PhD students typically share their time equally between the company and the university. The scheme funds the salary of the PhD candidate up to 30% – 50%; in addition it provides subsidies to the university for its operational costs. The programme has been evaluated regularly since its inception. The 2007 meta-evaluation⁶⁶ concludes that the scheme acts *"as an extremely effective network promoter between the private business world and university circles. It is an education that contributes to sending many highly educated people out into the business world often in management positions in research and development. The Industrial PhD programme thus contributes to growth and development within enterprises, creating new knowledge at universities and industrially relevant research in Denmark"* (DCTI 2007). Another important effect of the scheme is the lasting impact on universities in terms of acquiring new skills to develop cooperation with companies, even beyond the individual PhD projects. A 2011 assessment of the scheme⁶⁷ shows that: 1) people graduating from the Industrial PhD-programme have a higher rate of employment in the private sector than other PhDs; 2) they earn higher salaries than other PhDs; 3) there is a positive impact from the scheme on firms' patenting activity; and 4) companies hosting Industrial PhDs are characterised by higher growth in gross profit (value creation) and employment.

Success factors for the Danish Industrial PhD were identified in the 2007 study:

- The scheme is user-driven, since the research is defined based on a company's needs, and the company owns the IPR of the research;
- The university provides research education at very high level as well as full support to the PhD candidate;
- The application and decision processes are quick and non-bureaucratic.

⁶⁶ The Danish Council for Technology and Innovation - DCTI (2007), *The Industrial PhD - An effective tool for innovation and knowledge sharing*.

⁶⁷ Danish Agency for Science, Technology and Innovation (2011): *Analysis of the Industrial PhD Programme*. https://ufm.dk/filer/publikationer/2011/analysis_of_industrial_phd/html/helepubl.htm

A study carried out by the European University Association (EUA) under the DOC-CAREERS II Project⁶⁸ confirms that: **holders of industrial PhDs acquire additional skills that contribute positively to their employability in the private sector; university-industry cooperation is fostered** through the joint supervision experience and the opening of access to respective networks.

The EUA study identified the following good practices rules for the implementation of industrial PhDs projects:

- The importance of the **planning stage** should not be underestimated. It is necessary to build trust between the three partners: the academic supervisor at university, the company and the doctoral candidate. This requires a good understanding of each partner's needs and expectations and, accordingly, the design of a contract with realistic goals, clear collaboration rules and precise agreements with respect to financial and IPR issues. At this stage, care should be taken to ensure that **the research project really fits with both academic and company strategies**;
- During **implementation, regular contact** should be maintained between the three partners to ensure smooth running of the research and an understanding of its evolution and possible changes in trajectory. The schemes should be **flexible** enough to accommodate such changes;
- **Academic and industrial supervision** should be given equal weight throughout the research. Experience teaches that goals are easier to attain when industrial supervisors themselves have a PhD degree, or at least have some understanding of the standards involved in acquiring a doctoral degree;
- **Interdisciplinarity** is an essential feature of many industrial PhDs.

Some difficulties with Industrial PhD schemes were also highlighted in the above EUA study:

- An unbalanced focus on either the academic or the non-academic activities;
- Limitations on the freedom of researcher to introduce breakthrough ideas;
- Tensions with respect to IPR issues;
- Difficulties with respect to joint supervisory work, differences in views and communication flaws.

Overall, the main challenge for Industrial PhD schemes is to achieve a **good articulation between the different views and expectations on the academic side** (research quality, training of the candidate), **the company side** (innovation leading to business development) and **expectations of the candidate** for his/her professional career.

⁶⁸ <http://eua.be/activities-services/projects/past-projects/research-and-innovation/doc-careers-ii.aspx>

4.4. Lessons on collaborative research programmes

A review⁶⁹ of a large set of evaluations of collaborative R&D programmes finds that such programmes generally **produce expected outputs** that are important both from the academic and business sides (such as publications, patents, patent citations, and innovative products) **while also generating collaborative linkages**. Looking at studies measuring the impacts of research collaboration on the academic partners, a general finding of Cunningham and Gök (2012) is that citations (a measure of the impact of publications) increase dramatically when academic researchers collaborate with industry, especially when this collaboration takes place at international scale.

An example from the UK illustrates some of the benefits to be gained from collaborative research projects, both from an economic and an academic perspective:

- An evaluation⁷⁰ of the long-standing collaborative research programme LINK in the **United Kingdom**, which targeted pre-commercial joint research activities, concluded that LINK brought substantial economic benefits to participating companies. The evaluation estimated that the programme, since its inception in 1986 through to 2002, had raised employment levels by 15,000 to 25,000 positions and generated between £700m and £2,400m in terms of increased turnover and between £250m and £500m in terms of increased profit. From an academic point of view, the programme helped to strengthen research capabilities, diversify the knowledge base and upgrade researcher training. The programme also helped to deepen existing collaborations and create new ones, which were expected to last after the end of the supported projects. The quantity and quality of scientific outputs produced by the programme were found to be similar to those acquired through other funding programmes.

The review by Cunningham and Gök (2012) identifies the following success factors for these programmes:

1. The **long-term and stable commitment** of government funding and support for collaborative schemes;
2. The **clarity of the rationale and objectives** initially set for programmes and the introduction of **changes** in programme definition according to the evolution of needs and modes of cooperation by beneficiaries;
3. **Flexibility** in the implementation of programmes at the individual project level, allowing, for example, changes in partners or in the direction of research, since these are natural occurrences in the evolution of longer-term partnerships and projects carrying a high degree of risk;
4. **Equity** in sharing workloads and the benefits of collaborative research, ensuring in particular that benefits accrue to all parties;
5. Minimal **bureaucracy**;
6. A strong and positive **brand image**, which fosters not only the attractiveness of the programmes but also further cooperation beyond the supported projects;

⁶⁹ Cunningham, P. and A. Gök (2012), *The Impact and Effectiveness of Policies to Support Collaboration for R&D and Innovation: Compendium of Evidence on the Effectiveness of Innovation Policy Intervention*, Manchester Institute of Innovation Research, Manchester Business School, University of Manchester. <http://www.innovation-policy.org.uk/compendium/section/Default.aspx?topicid=22>

⁷⁰ Smith, D., Griffin, M., O'Neil, P., Rees, J., Skingle, M., Stewart, W., D. Yarrow, D (2003), *Strategic Review of LINK Collaborative Research*, Report of the Independent Review Panel. <http://www.innovation-policy.org.uk/compendium/reference/Default.aspx?referenceid=655>

7. Good **articulation with other programmes** or schemes that aim to exploit the results of collaborative research.

The first success factor is linked to the fact that the impacts of collaborative research programmes take time to become visible, hence programmes should have persistence over time. This can be illustrated by the case of Tekes programmes in Finland:

- The Tekes programmes have been the main instruments deployed in **Finland** to support technology development of importance to the construction of a knowledge-based economy. An overall evaluation of Tekes⁷¹ concludes that these programmes have a long-standing history and that each of them builds on achievements (results and networks) of its predecessors, while incorporating the needed modifications according to changes in the research and industry landscape.
- Regular evaluations of the impacts of the programmes have had an impact on their overall evolution. Over the years, the size and duration of the programmes have tended to increase. The programmes have also developed a greater focus on business impacts and institutional changes (e.g. industry platforms). The evaluations generally found that the programmes were effective in creating lasting linkages between businesses and researchers in the public sector. The impacts on new products and commercialisation differ across the various programmes. Impacts are stronger in new emerging fields than in more mature ones (Technopolis 2012).

The second success factor concerning the importance of clarity of objectives is well illustrated by the example below:

- The Knowledge Foundation⁷² is a **Swedish** programme that funds activities conducted collaboratively between academic staff and business sector partners with the aim of building internationally competitive, integrated research and education environments. It uses the **concept of co-production**, i.e. shared production of knowledge, whereby academia and companies solve problems and work together to attain research findings. The programme uses four criteria (Figure 8) for both evaluating applications and for following-up funded projects. These criteria are clearly communicated to both universities and their corporate partners. At the Universities, research coordinators are aware of these criteria and arrange workshops for potential applicants regarding what the criteria mean and how they are operationalised. The criteria are not only something of interest when one writes an application, but they also matter when planning a consortium, when engaging external partners who might wish to participate, when planning project implementation and evaluation and when expanding on the projects. It is crucial that the criteria are perceived as 'neutral' and are based on quality. Once 'buy-in' has been achieved among relevant stakeholders, and success has been demonstrated through an approved application, it is straightforward to expand on the activities and to seek additional funding for new projects. The projects supported by the Knowledge Foundation over a 20-year period show that **co-production drives research forward and leads to research findings**. Through co-production, research scientists not only gain insights into real problems, but also gain access to better and real data for their research.

⁷¹ Technopolis (2012), *Evaluation of Tekes*, Publications of the Ministry of Employment and the Economy, Innovation, 2/2012

⁷² "KK-stiftelsen", see <http://www.kks.se/om-oss/in-english>

Figure 8. Criteria used in the Swedish Knowledge Foundation collaborative research programme



Source: KK-stiftelsen

The seventh and last success factor is related to the earlier discussion on policy mixes in that it points to the need to develop a well-articulated set of instruments targeting all aspects of the 'science-business gap', of which collaborative research programmes are only one element.

5. Challenges

Questions to focus the discussion of this Challenge Paper in the meeting in Brussels on 14-15 May 2018

Q1: The policy mix for science-business cooperation: how can a good balance be struck between the three broad pillars of the policy mix: reinforcing HEIs/PROs' orientation towards business needs; strengthening the absorptive capacity of businesses for research results; and providing 'co-creation spaces'?

Q2: The policy mix for science-business cooperation: what place is there for competence centres and other 'complex PPPs', which are becoming the new fashion for promoting science-business relationships? Should they progressively replace other schemes based on linear technology transfer concepts or co-exist with them?

Q3: The policy mix for science-business cooperation: to what extent should the individual components of this policy mix take into account the diversity in nature of HEIs/PROs targeted by the schemes and programmes?

Q4: The policy mix for science-business cooperation: what can be done if the 'demand-side' for research cooperation is weak (i.e. if companies are either unwilling or unable to cooperate)?

Q5: The policy mix for science-business cooperation: what are the best ways to boost the human resources dimension of the policy mix?

Q6: The policy mix for science-business cooperation: how can shared responsibility for a policy mix between Ministries in charge of Science and Research and Ministries in charge of Economy be organised?

Q7: TTOs: what are the impacts of the new 'co-creation' paradigm (which moves beyond simple technology transfer) on the definition of missions, models and mode of operation of TTOs? How can decisions be taken concerning the relevant activities that should be conducted in TTOs or elsewhere in the system? How far can governments steer TTO activities?

Q8: TTOs: what are the right metrics to measure the different impacts of TTOs and the quality of their contribution to the overall goal of supporting science-business cooperation?

Q9: TTOs: how to decide between comprehensive and specialised models? Between exclusive and shared models?

Q9: Industrial PhDs: are these a silver bullet? Is this scheme appropriate for all research and innovation ecosystems? What complementary measures are needed to ensure effective benefits from these schemes?

Q10: Industrial PhDs: how can a good articulation be achieved between the different views and expectations of academics, PhD candidates and companies? What are the conditions for this to be achieved?

Q11: Collaborative research programmes: how can the tension between the need for stability and the need to evolve new modes of cooperation between industry and the science base be resolved? How should selection criteria evolve and be implemented?

Q12: Collaborative research programmes: what balance is needed between concentration on the strong 'regular clients' of such programmes and openness to newcomers?

Q13: How to avoid a 'boomerang effect' from putting too much pressure on science-business collaboration?

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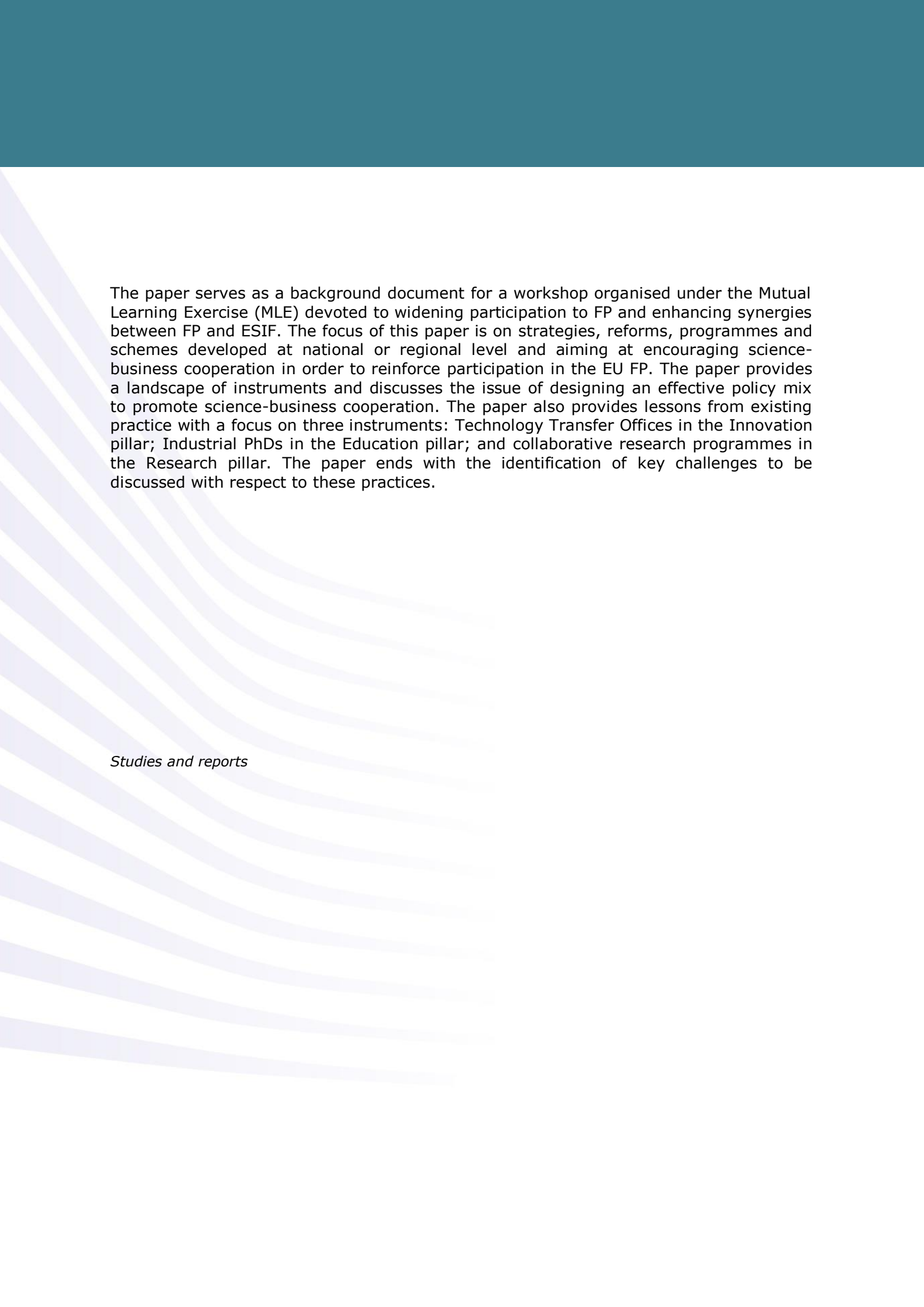
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The paper serves as a background document for a workshop organised under the Mutual Learning Exercise (MLE) devoted to widening participation to FP and enhancing synergies between FP and ESIF. The focus of this paper is on strategies, reforms, programmes and schemes developed at national or regional level and aiming at encouraging science-business cooperation in order to reinforce participation in the EU FP. The paper provides a landscape of instruments and discusses the issue of designing an effective policy mix to promote science-business cooperation. The paper also provides lessons from existing practice with a focus on three instruments: Technology Transfer Offices in the Innovation pillar; Industrial PhDs in the Education pillar; and collaborative research programmes in the Research pillar. The paper ends with the identification of key challenges to be discussed with respect to these practices.

Studies and reports