# KNOWLEDGE TRIANGLE SYNTHESIS REPORT:

## ENHANCING THE CONTRIBUTIONS OF HIGHER EDUCATION AND RESEARCH TO INNOVATION

OECD

## ABSTRACT

This report focuses on the knowledge triangle as a policy framework to enhance the contributions of higher education institutions (HEIs) and public research institutions/organisations (PRIs/PROs) to innovation eco-systems at national, local and global levels. The knowledge triangle is a practical policy framework that focuses on integrating the missions and functions of higher education systems notably, education, research, innovation and societal engagement. The report provides a comprehensive overview of the theoretical and practical basis of the KT framework and a set of policy recommendations based on lessons from national and institutional reforms in OECD countries.

The report benefited from discussion and comments at the December 2016 meeting of the OECD Working Party on Innovation and Technology Policy (TIP) and was declassified by the CSTP in 2017. The report was prepared by the OECD Secretariat.

*Note to Delegations:*

*An earlier declassified version of this document is available on O.N.E. Author with the cote: DSTI/STP/TIP (2016)10/REV1*

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The Knowledge Triangle activity was carried out by an OECD Secretariat team (Mario Cervantes, Giulia Ajmone-Marsan, Caroline Paunov and Richard Scott). Caroline Paunov led the module on impact assessment while Giulia Ajmone-Marsan led the module on place-based policies and authored Chapter 3 of the synthesis. Mario Cervantes managed the project under the direction of Dominique Guellec and drafted Chapters 1 and 4 of the synthesis. Wolfgang Polt and Maximillian Unger of Joanneum Research drafted Chapter 2 of the synthesis regarding the conceptual basis and empirical evidence of the KT policy framework and its relation to other frameworks such as the "triple helix" or the entrepreneurial university. Taran Thune (Norway) and Wolfgang Polt (Austria) assisted the Secretariat in developing the template used to enable comparisons of the country case studies. In addition, the synthesis report distils the findings from analytical work carried out over past two years, which includes:

- Sixteen country case studies of higher education eco-systems in the knowledge triangle carried by national experts and Delegates whose names appear in the summaries of the case studies in Part II of this synthesis.
- A review of Chile's public research centres from the perspective of the knowledge triangle, prepared by the Secretariat (OECD, 2015*a*) with support from external consultants, Wolfgang Polt, Steven Wooding, Nick Vonartas and Jean Guinet.
- A study on the role of education, entrepreneurship and innovation policies in fostering a business innovation culture in Canada, prepared by the Secretariat (OECD, 2015*b*) with support from external consultant Daniel Kupka.
- A scoping paper on Higher Education Institutions and the Knowledge Triangle (OECD, 2015c) by Mario Cervantes and Richard Scott.
- A scoping paper on Place-Based Policies and HEIs (OECD, 2015*d*) by Giulia Ajmone-Marsan.
- A paper on Emerging Policy Lessons from the Knowledge Triangle (OECD, 2016*a*) by Mario Cervantes and Richard Scott.
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## EXECUTIVE SUMMARY

Enhancing the contributions of higher education institutions (HEIs) and public research institutions (PRIs) to innovation is critical to meeting many of today's social, environmental and economic challenges. Through their main missions; education, research and innovation/societal engagement, HEIs and PRIs generate new knowledge, train human capital and foster innovation and economic development. The past decades have seen greater efforts by governments to encourage universities to strengthen linkages between research and innovation, for example. The "knowledge triangle" policy framework, in contrast, promotes stronger linkages between the main missions of higher education institutions. In this way, the knowledge triangle is a framework to enhance both the quality and relevance of higher education. However, the fact remains that growing global competition for achieving research excellence and attracting top students places pressure on higher education institutions to specialise on one or two vectors of the triangle. Furthermore, the incentives in universities are not aligned in such a way as to encourage engagement with firms in terms of research and education. The lack of absorptive capacity in the business sector is also key barrier for efforts to promote the knowledge triangle.

This report urges policy makers, higher education institutions and business actors to take measures to increase the incentives for collaboration between higher education institutions, researchers, firms and societal actors such as by making governance structures more inclusive, developing dedicated funding streams for third mission activities, and developing appropriate metrics of the societal engagement activities of higher education institutions. The report provides guidance on the various strategies and policies, based on case studies in Part II of the report, to integrate the education, research and societal engagement activities of institutions so that the impacts on society are greater than the sum of the individual parts. In this regard, the report shows that the making the KT a reality requires:

- Aligning the research and education agendas of higher education institutions with the agendas of societal stakeholders so that supply of knowledge and talent is continuously linked to the market demands and societal needs.

- Fostering a place-based approach to higher education, research and innovation policy and thus helping to reduce productivity gaps and foster more inclusive innovation.

- Strengthening the governance of regional innovation systems, through a broader engagement of civil society, particularly of companies, regional governments, development agencies as well as citizen groups.

- Strengthening the local, national and global knowledge production and absorption capacities, through networking mechanisms within countries but also across regions and borders, as well as through multi-level governance mechanisms.

The KT framework is also context-independent and must be adapted and interpreted in order to provide guidance for policy makers. There may be conflicts or trade-offs in public policies (e.g. funding policies) and institutional incentives for researchers for example. The main policies recommendations for the knowledge triangle to contribute to innovation are presented below.

**Box 1. Guiding Principles and Recommendations for Achieving the Knowledge Triangle**

**Recommendations for government ministries and funding bodies**

***Public funding for higher education and research institutions***

- Funding and evaluations must explicitly recognise and reward innovation activities.
- Funding policies should better differentiate between institutions with different institutional profiles.
- Creating separate streams of funding for third-mission activities could leverage institutional funding.
- Maintaining a balance between competitive funding and block funding and the integration of the third mission is important.

***Agenda setting***

- Policy should define appropriate objectives for universities, but the institutions themselves should have a voice in the choice of appropriate measures by which to measure the achievement of objectives.
- Establishing close and mutual co-operation between HEIs and society, for instance by including representatives from public and private partners on university, faculty and department boards, as well as promoting the participation of university leaders on boards of private companies and economic development agencies consistent with ethical and conflict of interest rules.

***Increasing business demand for R&D and innovation from the KT perspective***

- For the knowledge triangle to work, government must provide businesses with the conditions to invest in R&D and innovation in order to be able to collaborate with universities.
- Governments have a range of tools to support collaborative research ranging from grants, pre-commercial procurement of R&D such as SBIR schemes and vouchers.
- More holistic assessment of such schemes from the perspective of the knowledge triangle would be welcome in order to improve programme design and delivery and boost business demand for university knowledge and talent.

***Government support to business-academic partnerships***

- Government support to digital platforms/online brokerage to help business find and connect to research and innovation opportunities in universities as well as to talent is important. However, such platforms alone cannot replace personal connections. Digital platforms must work together with people-based interfaces to act upon the connections. Intermediaries such as university-based tech transfer office (TTOs) could be mobilsed to reduce the information gaps as well as to activate connections.

***Mobility and human resources***

- Remove barriers to the mobility between academic and non-academic sector and to the recruitment of academic personnel with innovation skills and competence.
- Promote research projects that link excellent researchers with public and private partners.

**Recommendations for Higher Education and Research Institutions**

- Institutional changes in the management and steering of higher education systems are needed if institutions are to be more effective in implementing the knowledge triangle in practice.
- The implementation of institutional change at higher education and research institutions requires appropriate incentive mechanisms, whether this might be competitive public programmes, national or

regional strategies underpinned with dedicated budgets, specific measures embedded into public block-grant allocation mechanisms etc.

- Encourage KT interactions not only at tertiary education but also at the secondary and primary levels.
- Develop "learning spaces" where companies, students and researchers come together to learn and solve problems.
- Foster exchanges and collaboration between students and top researchers as well as entrepreneurs.
- Practice-based learning programmes to involve students in research projects.
- Mobilise digital technologies to give students new insights into frontier research and methods (e.g. data science).
- Remove institutional barriers between teaching and frontier research.
- Interaction between research and citizens is critical.
- There should be clear incentives for research to engage in knowledge triangle interactions.
- Funding should be earmarked or third mission activities at the institutional level and/or through third stream funding

**Recommendation on place-based policies for HEI**

- Public initiative should build on existing networks to achieve successful collaboration.
- Regional ecosystems should foster a diversity of KT approaches depending on different regions and regional stakeholders.
- Engage universities on economic development boards and councils ; similarly engage economic development agencies on university boards
- The knowledge triangle interactions should be open at the local and global level and involve civil society.

**Recommendations for the business sector**

- Business engagement with universities could be better integrated. Support for education often stops at funding for university equipment, endowed chairs, and fellowships and curricula setting but the KT approach implies deeper business involvement such as supporting experiential learning experiences that enable students to experience a real life work environment.
- Companies should see their engagement with universities as part of institutionalisation and relationship building.
- Business should seek to understand and contribute to the university agenda, not only to influence it. This will create win-win situations and longer term relationships
- Economic and commercial drivers of companies can be aligned with the institutional and societal engagement of companies. Public-private partnerships are one way in which firms can combine societal interests along with their business interests.
- Globalisation increases the need for firms to establish local connections with customers, but also with the knowledge eco-system of which HEIs are important actors.
- Having a seat on university boards is important to ensure agendas are aligned even as circumstances evolve.
- Firms, as organisations that depend on talent from universities, should support the creation of formal as well as informal, self-organised networks of company employees working with universities and PROs where information is shared, and innovation can flourish. Self-organised networks can be an asset to both firms and universities, especially when formal partnerships or arrangements may have

come to an end.

**Recommendations on metrics and impacts**

- Universities should themselves collect data on engagement with business and the broader community
- Universities should choose appropriate indicators in light of their mission and proposed objectives
- Metrics on knowledge triangle activities should measure genuine performance and avoid rewarding institutional features.
- Performance criteria should be broad enough to capture institutional diversity
- Any impact assessment should take into account national differences in framework conditions.
- Quantitative measures such as university research revenues should be complemented by case study evidence that captures activities that have a high impact but do not generate income.
- Metrics should be transparent allowing researchers and institutions to compare the methods behind measurement exercises.

**Recommendations for the international policy research community**

- Policy research and advice focuses heavily on the connections between innovation and research, but far less on the links between education to innovation or to research. This has to change.
- The relationships between the three KT corners should be emphasised further in the development of metrics and indicators developed at national and international level.
- The higher education and innovation policy research communities need to collaborate and develop joint insights and evidence useful for policy makers and other stakeholders.

# CHAPTER 1: POLICY HIGHLIGHTS

## 1.1 Enhancing the contributions of higher education and research institutions through the knowledge triangle framework

***The Knowledge Triangle is a common frame for different policy frameworks that aim to transform higher education and research systems…***

The knowledge triangle (KT) is an overarching policy framework for different theoretical concepts in science, innovation and higher education policy which in one way or another call for an integration of education, research and innovation activities and policies. Variants of this framework, some of which take an actor focus rather than an activity focus, include the "triple helix" (government-industry-university) put forward by Etzkowitz and Leydesdorf (2000) who concluded that the university model is changing towards an entrepreneurial model which stresses the application and exploitation of research. The quadruple helix (government-industry-university-civil society) further expands this model by involving civil society in the agenda setting of institutions. The "entrepreneurial university" model takes both an actor and functional focus (entrepreneurial education and entrepreneurship and commercialisation activities such as university-based start-ups and patenting activities). Finally, the civic and "challenge-driven" universities are extensions of the "triple helix model" as they try to institutionalise the innovation focus of universities, both in the teaching and research functions (project-based learning and problem solving, use of MOOCs) but also with regard to the engagement of universities with their local communities.

***…it implies a departure from the traditional view of knowledge production as a linear and sequential process***

A central idea behind the KT framework is that creating new knowledge from research and high quality education are in themselves not sufficient to improve social well-being and economic growth (Stam et. al, 2016). In contrast to linear pipeline model of innovation, it emphasizes *linking* the different functions of HEIs together with the different actors in the surrounding innovation eco-systems (i.e. a place-based dimension). In doing so it recognises the explicit role of education and entrepreneurship in the development and application of research and education to solve specific societal problems in place-based context, whether urban poverty, public health or the needs of local industries. The KT framework encourages mechanisms to link education to innovation via entrepreneurship for example; and to link innovation to education and research for example by permitting professors of practice from industry to lecture at universities. Knowledge flows in the knowledge triangle are therefore not unidirectional. Innovations in business can fuel basic research just as innovation and entrepreneurship can feed-back into education.

***The knowledge triangle concepts are well understood by policy makers but the focus should now move to implementation a wider scale***

Even if the concept or terminology of the knowledge triangle is fluid and varies across countries, regions and institutions, it is very much a practical and flexible framework that is being applied in many universities in OECD countries in the EU but also in Canada, the United States, Australia, Chile, Japan, and Korea and in non-member economies such as China and Malaysia. But in many countries the

institutions that are implementing the KT practices remain marginal in relation to the thousands of higher education and research institutions in OECD countries. In fact, despite the rhetoric around broader engagement, the reality is that increased investment in university research over the last 15 years or so has mainly led to a growing number of scientific publications and a global competition for scientific excellence (OECD 2016)

At the centre of the KT are higher education institutions (HEIs) and public research institutions (PRIs)…

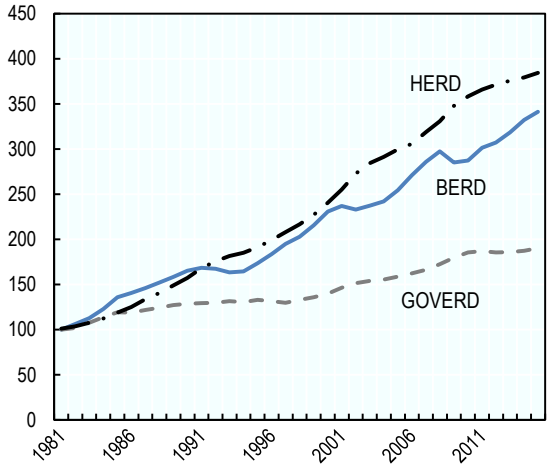
Higher education and public research institutions are the centre of efforts to promote the knowledge triangle. As the share of higher education expenditure on R&D (HERD) in total public research has increased steadily over recent decades in the OECD area, as the share of government expenditure on R&D (GOVERD) has declined (Figure 1.1). Much of the government funding that is dedicated to public research is spent by HEIs (Figure 1.2).

The rise in higher education R&D is associated with a concentration of research within countries as well; only a small percentage of universities carry out the majority of the research (Figures 1.3 and 1.4). This concentration has been accelerated, in some countries such as Denmark, the UK and even France by the mergers of public research institutes into higher education institutions (OECD, 2016). Such universities often have a considerable degree of autonomy in how they balance and implement their missions, which is influenced by both their size and relative wealth, factors that vary enormously even within individual countries. Furthermore, innovation in firms increasingly relies on the science base that is generated at HEIs as illustrated by the proliferation of public-private research partnerships, contract research, industry funding of higher education, industry-university collaboration (Figure 1.6) and science-patent linkages (OECD, 2016).

Concentration may reflect a combination of factors related to size and scale. There are framework factors to take into account, like the size distribution of cities; and some economic ones like reputation, which is extremely skewed. Policies can play in both directions, concentration or equality but also government policies, such as performance-based contracts and increases in research funding relative to education; co-location of industry near HEIs and PROs; and institutional policies such as the recruitment of "star" faculty to attract additional funding for students, research and business collaboration.

**Figure 1.1 Trends in BERD, HERD, GOVERD**

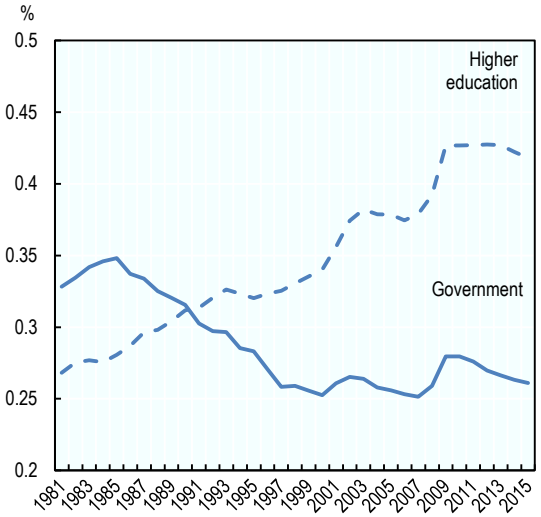
Index 1981= 100




*Source*: Calculations based on OECD (2017) Main Science and Technology Indicators Database, August 2017 www.oecd.org/sti/msti.htm.

**Figure 1.2 Public research funding has shifted towards high education institutions**

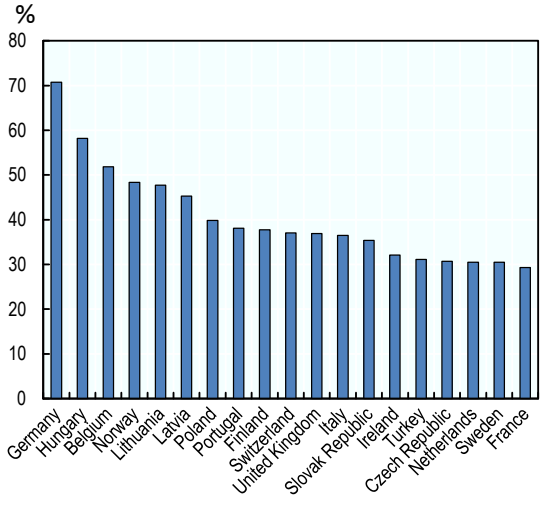
R&D expenditure as a % of GDP, total OECD, 1981-2015




*Source*: OECD (2017) Main Science and Technology Indicators (MSTI) Database, August 2017, www.oecd.org/sti/msti.htm .

**Figure 1.3. Concentration of Higher Education R&D in European Universities**

Share of total expenditures accounted for by the top 10% institutions, 2014

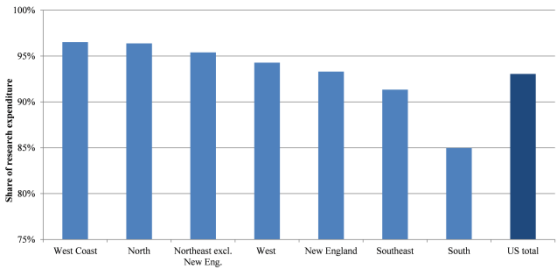



Notes: Expenditures are total expenditures for public institutions in countries with at least 10 observations. N=1412 and for which total Current expenditure by institution was available.

*Source:* OECD computation based on ETER, extracted on 9-August 2017 from https://www.eter-project.com.

**Figure 1.4. Concentration of Higher Education R&D in the United States (2012), selected regions**

Share of total expenditures accounted for by top 10% institutions in terms of total R&D expenditures, (2012)

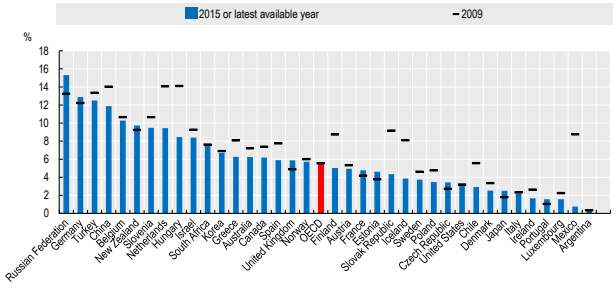



Notes: Institutions with no National Science Foundation R&D expenditure data are counted as zero expenditure. Expenditures are measured by core expenses (GASB accounting basis). N=1 935.

*Source*: OECD computation based on IPEDS.

**Figure 1.5. Public research funded by industry, 2009 and 2015 or latest available**

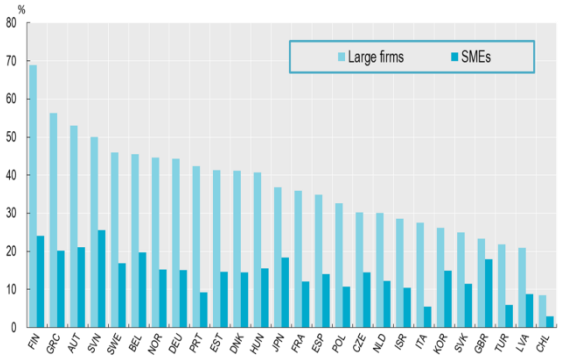
As a percentage of total higher education and government R&D expenditure




Note: Data for Argentina, Austria, Belgium, Israel, New Zealand, Norway, Sweden and South Africa refer to 2013 instead of 2015. Data for Australia, Canada, Germany, France, Italy, Luxembourg, Portugal, Spain, and Turkey refer to 2014 instead of 2015. Data for 2009 refer to 2008 for Australia and 2011 for Greece.

*Source*: OECD, Research and Developments Statistics (RDS) Database, April 2017, www.oecd.org/sti/rds; Eurostat STI Databases (http://epp.eurostat.ec.europa.eu/portal/page/portal/science_technology_innovation/data/database); Data retrieved from IPP.Stat on 10 August 2017.

**Figure 1.6. Firms collaborating on innovation with higher education or research institutions, by firm size, 2010-2012**




Source: OECD (2015), OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society, http://dx.doi.org/10.1787/sti_scoreboard-2015-en

### *HEIs are undergoing reforms that are pulling them in different directions…*

The place that HEIs occupy within national innovation systems can be argued to be inherently tied to long-term, structural economic factors in a path-dependent process (Mowery and Sampat, 2005). It is not surprising therefore that universities and public research institutes are on the one hand very heterogeneous, but also slow to change. Nevertheless, HEIs are facing pressure to measure and quantify their contributions not only to education and research but also to users (students), innovation, and civil society. In a way, these external pressures are forcing universities themselves to innovate and to better articulate their different missions in order to meet the demands from stakeholders and ensure their own posterity.

### *…leading to potential conflicts and tensions between policies and incentives*

But as policy reforms in tertiary education, in public research and in innovation policy have demonstrated, there may be conflicts in the direction of policies and incentives. On the research side, the global competition for scientific excellence has pushed governments to incentivise excellence in research and teaching. One outcome however is the excellence model for research funding and higher education policies have locked-in universities on development path or model that has "unwittingly disconnected [universities] from the nation-state and constituent cities and regions" (Goddard, 2016).

On the education side, the conversion or upgrading of technical colleges into universities or universities of applied sciences has also expanded the higher education landscape and forced institutions to better differentiate themselves and their education market offerings. Traditionally, higher education policies have been concerned with the contribution of education for labour market success or the training of higher quality graduates. Competition for students and pressure of government accountability have also created a focus on excellence in teaching that is promoted through assessment frameworks. Meanwhile

technological tools for teaching and learning such as massive online courses have changed the business model for delivering education and challenge institutions' funding and tuition arrangements.

On the innovation side, most policies in the last decade have focused on increasing the contribution of research to innovation through legislative reforms (e.g. Bayh-Dole Act) and the establishment of hard and soft infrastructure in the form of technology transfer offices or other interfaces between public research and industry. Moreover, collaboration with public research, whether in the form of science –push transfer of public research results to industry or demand-pull initiatives such as through public-private partnerships - has become the dominant discourse and a key focus of innovation policies. Even policies to support business R&D increasingly target collaboration between public research and large and small firms.

***Entrepreneurship at universities is a means to foster the adoption and diffusion of knowledge rather than its generation***

Entrepreneurship policies have also emerged as a means to increase the relevance of education to innovation and society by focusing on the application of knowledge rather than its generation. HEIs are being encouraged not only to educate and train entrepreneurs to apply knowledge but also to locate entrepreneurial activities on campus. In Norway for example, all HEIs have entrepreneurship education, either as a special study programme or as a course embedded in other programmes (Borlaug et. al, 2016). This is a rational development as entrepreneurship is a main channel through which knowledge developed at HEIs finds its way into innovation. In Russia National Research University Higher School of Economics provides innovation-related courses to students from all different disciplines with the aim of raising awareness and interest in entrepreneurial ventures among students.

At the same time, the KT framework recognises that there are both potential complementarity and potential conflicts between research, innovation and education policies. To mitigate against these conflicts, greater integration and dialogue between national policy makers, funding agencies and institutions must take place.

### 1.2 National policies in particular multi-level governance structures need to be strengthened.

The KT framework postulates that each of the linkages in the triangle can be strengthened by means of platforms and processes that build bridges between education, research and innovation (Sjoer et. al., 2011). At national level, the co-ordination of education, research and innovation policies is important. In many countries, this co-ordination takes place through inter-ministerial councils or through strategic documents (i.e. innovation strategy documents) that set out the direction for joint policy action. But co-ordination is needed also with regional and, increasingly, municipal governments. Findings from the case study of the HEI eco-systems suggest for example that the funding and management capabilities of regional boards has an impact the effectiveness of regional actors in steering entrepreneurial eco-systems (Stam, E., et. al., 2016)

Distinct funding, regulation, evaluation and assessment systems are one way government policies can account for the different expectations on different types of HEI. Based on a survey of institutions, Reichert (2009) finds that contradictory signals and reward structures in different European countries often mean that HEIs are incentivised to prioritise the same dimensions (those where resources are easiest to obtain), even in countries where there are explicit policies and instruments for diversity.

***The silo model of funding is a barrier to KT interactions***

Many countries have passed legal reforms to grant higher education institutions greater autonomy, giving institutions more control over the internal allocation of fund as well as strategic agenda setting and profile development of institutions. At the same time autonomy has come with accountability in the form

of performance agreements and evaluations of institutions. The corollary of greater autonomy granted to HEIs is that task of co-ordinating and integrating the multiple missions of universities falls on the institutions themselves.

However, the silo model of funding and regulations for the different missions, however, does not facilitate the tasks for institutions. This altogether places large expectations on universities to align the missions and create interaction between the different tasks (Benner, et al., 2015). This results in a dual (and sometimes fragmented) governance system: institutional choices are determined by internal governance structures (e.g. rectors, faculties and departments) that are influenced by (supra) national, and regional policies with regard to legislations, quality assurance, and funding.

***Implementing policies, including funding and evaluations must explicitly recognise and reward innovation activities***

Furthermore, governance mechanisms such as project-based funding, university performance contracts and research assessment exercises - which are common tools to increase the accountability of HEIs - may include a bias towards one or the other element of the knowledge triangle. An over-reliance on project-based competitive funding in Estonia for example has been detrimental to incentivising third mission actions as the time required to compete for grants leaves little time for engagement activities.

While explicit attention to innovation is important at the policy level, the implementing policies, including funding and evaluations must explicitly recognise and reward innovation activities. Indeed to remedy this, some countries like Spain have made third mission activities an explicit dimension of performance agreements. In other countries, the objectives are secondary. Tensions can nevertheless arise if many of these conditions are not properly reflected in funding mechanisms which generally remain focused on education and research excellence. The case of Sweden is illustrative. Although the government adopted the third mission as an explicit goal of universities, many institutions have struggled to allocate resources to reach this goal.

### 1.3 The KT approach requires modern institutional management and leadership.

Many reforms such as performance contracts have helped HEIs improve strategic planning and adapt to a changing funding landscape and position themselves in a global market for research and education. Analysis of case studies of HEI eco-systems suggests that adopting a KT approach requires modern management practices and leadership, not only at level of universities but also in the broader HEI eco-system (i.e. the vocational/technical colleges, PROs, clusters, regional development agencies). Another barrier observed in some of the case studies is that there are weak incentives for knowledge triangle practices in institutional recruitment and evaluation systems (Borlaug, Siri, B. et. al., 2016).

The management of the different missions in many institutions is uneven. While some institutions are good at managing research activities and outreach activities for research with industry, they are less proficient in engaging with local community and non-profits. Institutions should take a more strategic approach to managing their diverse asset and competences. One example of managing diverse assets is the development of "geographic learning spaces" or "knowledge clusters" - defined as the co-location of education, research and business in one setting. The University of Bergen has a strong business community surrounding it and is actively engaging it through co-creation that occurs from hosting IT and media companies on campus. Learning spaces and knowledge clusters must offer physical spaces, not just networks. Students are able to challenge businesses in these knowledge clusters.

***Diversification and leadership are needed to mobilise actors and resources for the KT***

Universities must embrace diversification and this means changing governance from a shared administrated model to a managerial one. Universities must make decisions on management and engage stakeholders in this process. However, the challenges to find the right incentives for research, third mission and transfer make the need for institutional and political leadership greater.

## 1.4 Place-based polices for the knowledge triangle

***The KT must be embedded in a geographic place that is open locally and globally***

Universities are located in cities, regions and countries. But in contrast to administrative boundaries of regions or countries, universities do not have borders to the same extent. Universities operate on both a local and global market for students and research talent. Technology further extends their reach as local teaching can be complemented by MOOCs and research is increasingly carried out internationally over digital networks and through the mobility of people. The aim of place-based policies has been to direct the activities of HEIs towards local needs, including innovation. The devolution of competences and economic development policies to agencies and regions has naturally brought education, entrepreneurship innovation policies closer to the world of higher education policies which has long had a strong regional or place-based dimension, even if some of leading institutions had become disconnected from their environment.

In lagging regions, especially, there is an expectation that universities can play a role fostering structural change. Policies for example in France aim at increasing the local impacts of universities; universities are supposed to favour partnerships with small and medium enterprises and be active in licensing to start-ups. In Germany, quantitative evidence suggests that KT development yields particularly higher effects on peripheral regions. The case of Bremen is illustrative. The University has increased its rankings on academic excellence while the University of Applied Science has developed an education profile dedicated towards the needs of the regional industry (Daimer and Rothgang, 2016). China has developed nationally designated “Innovation Demonstration Zones” such as Zhonguancun, Donghu, and Zhangjiang to link education and research for regional development.

To accomplish this, HEIs are increasingly engaging local stakeholders on university boards or for fund raising. However, the case studies in this report suggest that economic development agencies can arguably do more to engage HEIs in their public service delivery missions, economic development, urban planning or “smart city” initiatives. The case of the Brainport Foundation in the Eindhoven region of the Netherlands which is responsible for bringing HEIs, but also PROs and vocational education together with private organisations to promote the region is illustrative. The role of HEIs in the regions also depends on the relative power and motivation of the actors; in a government-pulled model, entrepreneurial universities assist the development of existing industries and the creation of new industries in response to incentives from government. In an industry-pulled model, universities respond to opportunities for co-operation with industry on specific problems (Lindqvist et. al., 2012).

## 1.5 Broadening university rankings and impact assessment to recognise KT interactions

***Current metrics of KT interactions are focused on research and education rather than third mission activities***

The contribution of universities to innovation is also dependent on the metrics used by institutions and policy makers to incentivise and measure performance. If universities are evaluated according to indicators based on academic excellence, then excellence is what will be rewarded. If universities are funded and evaluated to promote "third mission" activities like innovation and local economic development then universities will organise themselves in way to meet this goal.

Diversity of funding sources, performance indicators and evaluation practices make implementing and measuring KT activities difficult. The funding sources of HEI are increasingly diverse in terms of their origin (i.e. national, regional, international, business and charities) but also their nature (institutional block grants, competitive project-based, or industry contract-based). This diversity is reflected also in the indicators and metrics for monitoring the use and impact of the funds.

Evaluation results serve as a basis for the distribution of institutional funding of research organisations. While competitive funding streams often encourage the diffusion of research outputs to society, the metrics used will vary according to the project or reporting requirements of the funder. In some cases, however, KT activities are not included in the evaluation criteria. As a consequence, the indicators to evaluate HEIs are pre-determined and biased towards the goals/criteria of the funding sources.

One way to mitigate against the limits to performance metrics- especially in terms of measuring wider impacts - is to ensure transparency and safeguards that limit the scope for gaming measurement systems (OECD, 2016).

Self-assessment tools such as the OECD -EU HEI Innovate can help universities self-assess entrepreneurial performance based on a range of indicators, guidance and good practices material. Turkey's Entrepreneurial and Innovative University Index, which aims to increase innovation and entrepreneurship activities at universities, developed the indicators in co-ordination with universities as a means to obtain buy-in and legitimacy. Since 2014 in the UK, 20% of research performance is based on case studies on university impact under the Research Excellence Framework that allocates research funds to institutions. These are some of the ways to broaden the criteria. Evaluation should however be implemented in a way that limits its cost, both for the evaluating and the evaluated bodies, in order to make it sustainable.

Alternative metrics such as of downloads of university publications by industry and of industry publications being downloaded by university faculty can provide another source of the use of the knowledge generated by universities. Data visualisation tools are being used to determine collaborative patterns between science and industry, e.g. the number of joint publications, citations thereof, and the ratio of patent per scholarly output.

The OECD's Directorate for Education and Skills is launching work to benchmark higher education systems, which will measure higher education system performance in a range of activities and provide answers as to why some perform better than others.

## Concluding remarks

### *The KT requires a tailored approach; there is no one size fit all for institutions*

In conclusion, the 'optimal' shape of the knowledge triangle likely to vary across countries, regions, and institutions but this report has identified some common principles for national policies, higher education and institutions. Some of these are well known - such as providing incentives for institutions and funding for researchers to engage in third mission and innovation activities; using appropriate metrics to measure KT interactions. Still many institutions and governments are lagging behind in implementation due to internal leadership and management gaps or conflicting policy signals and incentives. It is time for action, as noted by the Spanish Vice-Minister for Research and Innovation, Carmen Vela Olmo, at the High Level Event on the Knowledge Triangle. The knowledge triangle will only be productive if it is embedded in a well-functioning entrepreneurial ecosystem. This means that multi-level governance arrangements between ministries, higher education institutions, local and regional governments must define the respective roles of stakeholders while enabling them to be held accountable. Finally, effective

governance for the KT interactions and networks necessitates the input of regional business leaders with a long term commitment to the region.

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# CHAPTER 2: THE CONCEPT OF THE KNOWLEDGE TRIANGLE

This chapter discusses the concept of the knowledge triangle (hereafter 'KT'), as it has gained of importance in recent years as a framework for innovation policies especially in European but also in other OECD countries. The concept has gained popularity because it emphasises an integrated ('systemic') perspective on the interlinkages between research, education and innovation. In this paper, we highlight the core of the concept and try to contextualize it with other, sometimes overlapping, sometimes complementary concepts, such as "third mission", "triple helix" (or in an extended understanding "quadruple helix"), "entrepreneurial or civic university" models and Smart Specialisation. Against this background we seek to analyse the roles, rationalities and challenges of different actors that are involved in activities according to each of the three spheres of the triangle. Actors are first and foremost higher education institutions (HEIs), public authorities, research and technology institutes and private sector companies.

After a section trying to clarify the concept, examples and empirical evidence for respective policies and activities aiming to realise the KT (either on national, regional or institutional level) will be discussed in the respective sections. These examples are intended to supplement the evidence of national case studies on the KT produced for the OECD project, either by providing additional information on specific activities that have not been in the focus of national case studies or from countries that were not participating in the OECD project with the provision of a case study. They were selected because they fit by one or another characteristic into the concept of the KT, since only just a few policies, programmes or institutional activities today explicitly refer to the KT as an overarching approach. They are supposed to be neither exhaustive nor best practice archetypes, but should rather highlight practical ways of implementing dimensions of the KT. Main source for the selection of examples are the OECD Reviews of Innovation Policy but also recent studies on the performance of innovation systems of states or regions undertaken on European (RIO Country Reports, Reports of the European University Association EUA) or national level. Examples will emphasize structural characteristics of policy measures, programmes, initiatives and institutional development in the context of the KT as well as, where available, also highlight findings about outcomes, effects or observed tensions.

## 2.1 Introduction

The concept of the KT, unlike models of knowledge transfer and the commercialization of scientific research, takes a more systemic approach on the *orchestration*[1] of knowledge creation and innovation processes by relating the three spheres of (academic) research and knowledge creation, education and training and (business) innovation. In the past, also other concepts have been developed, stressing individual actors and dimensions.

The concept of the 'third mission' calls for an extend understanding of HEIs mission, referring to their societal and cultural relevance and their role as provides knowledge transfer and commercialisation

[1] Wallin (2006) defines orchestration as: "*capability to mobilize and integrate resources for the purpose of providing an offering to a customer and simultaneously create value for the customer, the orchestrator, and the network members involved. The orchestrator considers the constraints, based on which conversations are nurtured, to define and execute the purposeful resource allocation to create, produce, and provide the customer with the offering*".

activities. It has been taken up in government as well as institutional policies in many countries in recent years (OECD 2015).

The concept of the so-called entrepreneurial university, as introduced by Etzkowitz in 1983, aims to reflect this new understanding of universities' tasks and organisational characteristics and was further developed by e.g. Etzkowitz et. al. 2008; Foss and Gibson 2015. Whereas the 'third mission' serves as a summarizing term for an expansion of universities core missions, the concept of the entrepreneurial university emphasizes first, entrepreneurial activities of universities, mainly relying on their research activities, and second, a new management paradigm for the provision of universities' tasks.

The concept of the 'triple helix' (or in its extended understanding, the 'quadruple helix', also incorporating actors from the civil society, such as citizens, NGOs, consumer organizations etc.) highlights the importance of a systemic coordination of actors from the higher education and business sector with public authorities to contribute to innovations and knowledge based growth [see e.g. Etzkowitz and Leydesdorff (2000); Leydesdorff, L. (2012); Ranga and Etzkowitz (2013)].

It has to be noted though, that the KT concept is not meant to supplant existing concepts, some of which have found their way into policy strategies and documents and may be already well-anchored in the STI policy of a country or the strategy of an institutions. Primarily, it was applied throughout this project to provide a common frame for analysis of different policy frameworks that are in use in different countries. In some countries, KT is also used as an 'umbrella framework' to include all other approaches.

The concept of the KT is a functional model of interaction alongside these three spheres. Channels of interaction between the spheres include:

- *Research and Education:* geographic and sectoral mobility of graduates, postgraduate training programmes, basic and applied research as the basis for research-led teaching and measures to improve the skill-matching between companies and graduates.
- *Research and Innovation:* support and intensification of the transfer of knowledge about, for example, via i) public-private partnership models (e.g. clusters, science parks), ii) the commercialization of publicly funded research (IPRs), iii) contract research and development services from universities for the industry sector, iv) university spin-offs and academic start-ups, v) knowledge and technology transfer offices (TTO), vi) incubators, vii) open science / open innovation platforms.
- *Education and Innovation:* support for the development of an entrepreneurial culture (entrepreneurial spirit) in the framework of (academic) training programme (e.g. industrial PhDs) and appropriate competencies (business plan development, management etc.).

The concept of the KT covers much the same ground as the concept of the triple helix as systematisation of university-industry-government relations, reflecting and advocating a shift in policy paradigms towards an integrated approach of policy making based on skills and innovation capacity of societies. Whereas the KT takes an *activity*-oriented perspective in interlinking the spheres of education, research and innovation, the triple helix takes the *actors* in the respective national or sub-national innovation systems as a starting point.

The concrete manifestation of interactions in the KT is dependent on the structure of the respective national or regional innovation system. The national innovation system approach [e.g. Lundvall (1992); Edquist (1997)] emphasises the systemic assessment of the roles, responsibilities and governance interactions related to education, research and innovation actors on the political/strategic as well as on operational levels (ministries, administrations, public and private intermediaries and institutions).

Measures, activities and exchange processes along the three axes of the KT are determined by the respective national, regional or local actors' group structure.

The innovation eco-system model (e.g. Jackson (2011) represents yet another way to conceptualise interactions according to the KT, as dynamic extension of network-based innovation system model. In addition to the characterization of interactions between actors, also input flows to R&D and innovation such public and private funds, venture capital, as well as human capital, infrastructures or outputs in terms of innovations or profits are considered.

An important aspect of this approach is that it is not limited to formal/institutional connections between the different actors. Resources from science, research and education for innovations can also be acquired via commercial activities or even be of non-monetary nature, such as tacit knowledge that is accessible via informal linkages e.g. geographical proximity, common specializations, individual networks etc.

The concept of open innovation (Chesbrough 2003) also has a great deal of overlap with the concept of the KT as it refers to a continuing connection and progression of knowledge as basis for innovative processes rather than an input-output logic – from internal knowledge-production and acquisition to the final product. It therefore serves as new logic for R&D and innovation processes of companies, calling for a joint and stakeholder involving

i) Selection and perception of external knowledge.

ii) Identification of knowledge gaps.

iii) Development of system architectures (platforms, labs etc.) for the integration of external knowledge.

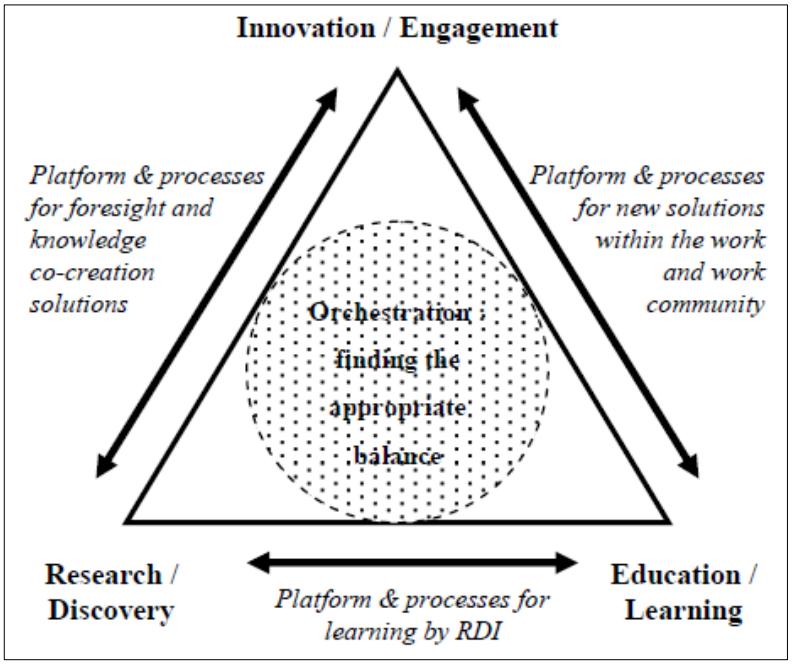
iv) Anticipation of user needs in the innovation process. It has gained attention in innovation policy concepts in many countries in recent years (e.g. Finland's Open Innovation Platform Model as part of the 6 Cities Project[2] or Austria's Open Innovation Strategy[3]). Despite those conceptual similarities, *open innovation* processes could also be established without academic engagement in purely company-centred models, and hence it is no substitute to the more holistic model of the KT.

Hence, the concept of the KT falls into the category of systemic innovation concepts. As Markkula (2013) states: "The Knowledge Triangle concept relates to the need for improving the impact of investments in the three activities – education, research and innovation – by systemic and continuous interaction." Hence, the KT can be defined as a set of actors, policy spheres (education, research, innovation) that spans the room for collaborative activities.

2 https://6aika.fi/in-english/.

3 http://openinnovation.gv.at/.

**Figure 2.1. The Knowledge Triangle of education, research and innovation.**




*Source*: Sjoer et al. (2011).

In the following, i) actors, ii) transfer mechanisms and iii) policy paradigms related to and engaged in the concept of the KT are presented and discussed with emphasis on the following leading questions:

- *Which types of actors are engaged in the KT?*
- *What are challenges in terms of governance approaches towards the interlinkage of the three corners of the triangle?*
- *What are characteristics of policies that may affect or support the design on the KT?*

At the end, some tentative conclusions regarding the usefulness of the KT as a policy tool, an economic/social model or a guiding principle for institutions are presented.

## 2.2 Main actors in the Knowledge Triangle

### *2.2.1 Higher education institutions*

Higher education institutions are the main backbone of the KT, first because they provide key inputs for each of the corners of the KT and second because – depending on their specific portfolio regarding the provision of education, research and other activities attributable to innovation – they often institutionally incorporate the KT also in their internal organisation and missions.

The assessment of HEIs' contribution to different corners of the KT has to take into account the great variety of different types of institutions in this sector, in terms of their mission to perform education and research, their ownership structure and institutional autonomy, their mandate to engage in third-mission activities beyond research and hence their role for the national/regional innovation system.

In a broader definition, higher education institutions are typically classified as i) universities, performing research and research-oriented teaching and ii) universities of applied science or university colleges, typically providing professional-oriented education (in many cases area specific) and, typically in a limited amount, applied research. Other types of institutions in this vein comprise academies of science performing PhD-education and higher education institutions that serve specific professions, e.g. nursing schools, pedagogical colleges or business schools that may often focus on specific educational levels such as Bachelor or Master studies. The importance of different types of institutions varies between countries.[4] But variety does not only exist between different types of institutions but also between institutions of the same type, e.g. with respect to differences in scientific and education topics, the endowment with resources, the organisational structure and capability of internal governance mechanisms and the connectivity with other institutions, companies and society, to mention just a few of the major characteristics. Thus, recognising this considerable degree of diversity in the higher education sector it becomes obvious that policies aiming at improving HEIs engagement in the KT have to flexible enough to be calibrated against the individual institutional configuration.

Compared to other types of higher education institutions, by their nature, universities provide services feeding into at least two corners of the KT, tertiary education and research, and relate these two spheres according to the concept of research-oriented education. The role of universities has to be reflected against a couple of general trends that do not only affect their traditional missions but also broaden the spectrum of potential activities. In particular, these are:

- Trend towards decentralisation of governance and greater autonomy of institutions, combined with shifts in funding towards greater emphasis on performance and competition affecting universities' ability to autonomously allocate resources, set strategic targets and shaping their profile in research and education;

- Increased international connectivity, allowing on the one hand for exchange and mutual learning in research activities and education practices, leading on the other to increased competition between institutions for research talents and students;

- An increasing formalisation of the expanding scope of third mission activities of universities beyond education and research in recent funding schemes, innovation strategies and related policies. These changes of the roles of universities have been reflected in changes in the frameworks in which these roles have been conceptualized, namely the concepts of 'third mission' and 'entrepreneurial university'.

During the dual move towards increased autonomy and accountability for HEIs in most countries, many countries have acted to strengthen and formalise the social and knowledge transfer role of HEIs. In Sweden, for example, the 'third mission' is officially recognised in the Higher Education Act since 1997 (OECD 2015). The emerging importance of the knowledge-based economy also calls for a new understanding in the perception of tasks by universities. E.g. Gibson and Foss (2015) identify two major types of 'entrepreneurial' activities of HEIs:

- *Entrepreneurial education*, i.e. the promotion of an entrepreneurial spirit among students and graduates as part of the academic education programmes, e.g. by specific courses, joint labs and platforms for co-creation with the industry or inter-sectorial exchange programmes.

[4] E.g. see ETER: https://www.eter-project.com/about/eter.

- *Entrepreneurial activities* and *academic entrepreneurship*, undertaken and supported by both, individual researchers as well by the university as an institutions. The first may comprise the creation of spin-offs and academic start-ups, the production of IPRs or the engagement in collaborative research. The second comprises e.g. the development support structures for commercialisation such as technology transfer offices (TTO) or industrial-liaison offices (ILO).

With the evolution of the concept of the entrepreneurial university, especially towards the formulation of the *triple-helix* model, as public-business sector-academic engagement model, emphasis was put on the idea that universities have to anticipate entrepreneurialism as a basic principle of their organisation. This comprises the transformation of universities' capabilities in terms of management and organisational structures towards becoming autonomous and strategic actors in the innovation system. This institutional transformation in the perception of universities' tasks and roles can be analysed along three major pillars (Scott (2014) :

- The regulative pillar comprises the legal framework, governance mechanisms and monitoring;

- The normative pillar, i.e. the role that is ascribed to universities according to expectations, societal values, the surrounding environment, conventions and standards;

- The cultural-cognitive pillar, i.e. the acceptance of an entrepreneurial role model by individual researchers and HEI teachers.

The evolution of how entrepreneurship and entrepreneurial activities are becoming part of universities duties is dependent on several institutional factors: institutional autonomy, funding streams and governance mechanisms as well the availability of a surrounding entrepreneurial ecosystem. Furthermore, from a system's perspective of HEIs role in the innovation system, a distinction can be made between exogenous (top-down) and endogenous (bottom-up) factors in shaping universities transition towards entrepreneurial institutions (Etzkowitz et al. 2008). The first may comprise external shocks, like the economic crisis from 2008 and resulting grand societal challenges that call for knowledge based and sustainable solutions attributing a key role to universities as partners in shaping new solutions and innovations. The endogenous factors include internal transformations of the institutions themselves, e.g. organisationally, or regarding strategic targets or the bottom-up co-ordination of institutions in the provision of their services e.g. in university conferences.

Given the variety of exogenous and endogenous factors that affect universities, it also becomes obvious that the concept of the entrepreneurial university cannot be treated as homogenous model. Bronstein and Reihlen (2014) developed a typology of different characteristics of entrepreneurial universities based on a meta-analysis of structural features of institutions, such as governance and organization models, human resources, financial resources, infrastructures, missions and strategies, location and environment. They identified four different university archetypes:

- **Research-preneurial:** focus on advancement of knowledge and scientific excellence; traditional academic organisation structures (departments, faculties); high degree of public funding (basic and competitive funds); often host of large research infrastructures; outreach activities and industry-science relations and commercialization activities are characterized by the strive for external funding, based on academic specializations and reputations and might occur on the level of projects, (joint) research centres, ILOs and TTOs;

- **Techni-preneurial:** focus on applied science but still mostly publicly financed; strong linkages with surrounding industries, both institutionally and on staff level, as direct provider of knowledge; emphasis on inter-sector mobility (tailor-made academic programmes in conjunct

with industry, entrepreneurship education, on-the-job training); high degree of regional embeddedness;

- **Inno-preneurial:** focus on innovative services and solutions for the business sector; flexible structures to adapt to market characteristics; high degree of private sponsoring e.g. for professional schools; incentive structures emphasizing innovation and entrepreneurialism; knowledge transfer and commercialization activities include business services and consultancy; typically located in large urban areas and clusters;

- **Commerce-preneurial:** focus on commercialisation of innovations and marketable products in specific high-tech sectors; strong links with industry in joint projects and ventures; entrepreneurial infrastructures such as business units, incubators and technology parks are core institutional facilities; high importance of market-oriented project funding; managerial governance structures; emphasis on public relations and marketing.

The authors present a series of examples of HEIs for each of these archetypes, e.g. Stanford University, Technical University of Munich, University of California at Berkeley and Universidad Católica of Chile for 'research-preneurial' institutions. Among 'techni-preneurial' institutions the University of Joensuu, University of Waterloo and Hamburg University of Technology were highlighted. Examples for 'inno-preneurial' institutions were found to be the University of Joensuu, University of Waterloo and the Hamburg University of Technology. Representors of the 'commerce-preneurial' archetype were argued to be the Twente University, Bandung University of Technology, and Waseda University in Japan. Though one might be able to identify examples that serve as perfectly fitting prototypes for each of these archetypes, most universities actually could be attributed to more than one, due to their mostly multifunctional roles, stemming from path dependencies in their development, governance structures, environment and culture.

Another concept gaining importance in the recent past that puts emphasis on an extended understanding of HEIs' functions for societies is those of the *civic (or engaged) university* (see e.g. Goddard 2009, Henke et al. 2015). The fundamental premise of this role model is that HEIs are seen as providers of public goods, hence research and education outputs should not solely be assessed in terms of quantities and excellence but in terms of their relevance for society. This especially includes the potential to contribute knowledge to the solution of societal challenges such as e.g. ageing, sustainable energy production, smart mobility solutions etc. Another core function of the civic-oriented model is the contribution to social inclusion by striving to contribute to egalitarian education possibilities for all societal groups. Typically civic engagement of HEIs has a strong place-based dimension, with emphasis on their direct impacts in their regional environment, as well be also argued in the later section on place-based policies (Chapter 3). Hazelkorn (2015) pointed out some examples of how the anticipation of the civic university as institutional role model could be realised along the three axis of the KT:

- Education – Research axis: research informed teaching that utilises real life research projects in the classroom, student engaging in research projects based on university expertise to help solving complex, comprehensive and interconnected problems of cities or regions;

- Education – Innovation axis: students' work on projects with real public or private clients applying their specialist subject skills and receiving course credits for their work; community engages in teaching process and vice versa benefits from the student's work;[5]

- Research – Innovation axis: Focus on problem-solving, use-inspired research which makes a real impact on people's life experience.

Both the concepts of 'entrepreneurial' and 'civic' universities call for an extended understanding of HEIs contributions beyond research and teaching that also require institutional re-definitions and organisational changes. But there are also tensions between these two models as entrepreneurial managerialism, emphasising efficiency of resource allocation in terms of commercial and excellent outcomes and revenues might be in conflict with societal targets, which are often intangible in the short run. On the other hand, innovative and flexible structures of an entrepreneurial model might benefit the anchoring of societal outreach activities and creative channels for new solutions.

**Box 2.1. The US Arizona State University Model: a student-centred approach in university's strategic vision**

The US university sector is one of the most renowned in the world, with institutions such as Harvard, Stanford, Princeton or the Massachusetts Institute of Technology frequently holding top ten positions in the international rankings. But state funded public universities, other than those aforementioned private funded ones, such as the universities of California, Los Angeles or Chicago also hold top positions regarding their reputation as research and education institutions. Traditionally the role of private and public universities in the USA, compared to colleges and other tertiary education providers, has been that of research institutions providing research-based and higher-level education- even if many institutions, notably the State Land Grant universities had also mandates to serve their local communities through the applications of engineering and science.

The high level of competition between universities for research talents and students is considered to be a core principle and major success factor, pushing institutions towards striving for excellence and reputation. This emphasis on competition as well as the private foundations and respective linkages of many universities is also seen to be supportive for the development of an entrepreneurial spirit of both, the institutions as well as the individual researchers and students. With the implementation of the National Institute of Health and the National Science Foundation in the middle of the 20th century as well as big government programmes such as the moon-landing or armor programmes, also large amounts of public funds became available for the, formerly mainly tuition funded, academic sector (see Mazzucato, M. [2013], Cole, J. R. [2016]). The Bay-Doyle Act of 1980 was another important factor to push technology transfer of higher education institutions. As a result many ground-breaking innovations, companies as well as Nobel Prize laureates emerged from this system, especially in the past century.

Nevertheless, today's academic sector in the US is confronted with a variety of challenges, stemming from the trend towards a greater demand for tertiary education and resulting problems such as student indebtedness due to extraordinary tuition fees, and tighter higher education budgets of many US states for their universities. These developments are calling for US universities, especially the public ones, to reinvent themselves, by combing the need for high quality and inclusive tertiary education with research outputs and knowledge that feed into innovations and public wellbeing, a role model that is also called the 'New American University'.

The University of Arizona (ASU) is often referred to as a role model for how a university implemented a self-led strategic re-definition process as whole institution. This process, initiated in the early 2000s resulted in the "academic platform"-model as a new understanding of higher education institutions, by combining three foundational design components:

[5] One example in this vein is the Finnish' 'Open Innovation Platform Model' with practical implementations of IT solutions involving students and companies or the Campus Arena, aiming to engage companies and students in joint projects, both located at the Technical University of Tampere.

- Commitment to discovery and knowledge production as with the standard mode, linking pedagogy with research;
- Broad accessibility to students from highly diverse demographic and socio-economic backgrounds;
- Commitment to maximize societal impact by anticipating enrolment demand and national needs.

These components are manifested in ASU's mission statement, stipulating eight calls for action: i) leverage the place of the university, ii) enable students success, iii) transform society, iv) fuse academic disciplines, v) value entrepreneurship, vi) be socially embedded, vii) conduct use-inspired research, viii) engage globally.

Several steps have been undertaken towards the implementation of these targets. Most prominent was the creation of new interdisciplinary research institutes and schools, such as the Biodesign Institute, bringing together molecular research and biomedicine, the Exploration School, fusing astronomy and geology or the School of Human Evolution and Social Change, including the subjects mathematic, epidemiology, anthropology, political sciences and geography. The aim is to increase the societal impact of research results and educations by tearing down walls between familiar scientific disciplines and fields of education.

Other measures comprise attempts to ease students' financial burdens, e.g. by increased grants and scholarships or by partnerships with companies to provide students jobs on the campus area. New learning tools have been established or expanded, such online courses or a project-based learning initiative to allow students to tackle required, general-education courses through team-driven projects. In a partnership with the city of Phoenix a new campus in Downtown Phoenix was built, to increase ASU connectivity with the local environment.

The progress along the fields of actions is monitored by detailed reports, providing information and indicators on several dimensions such as student success, ethical diversity of students and staff, research and innovation out, societal collaborations, the performance in national and international rankings etc. An often mentioned success of the restructuring process of the ASU is the massive increased intake of federal public research grants of 162 % between 2003 and 2012.

But the actual success of the developments at ASU is also put into question. One argument is that the actual degree of the organizational changes is limited, since only few departments have actually been eliminated, with the new interdisciplinary institutes have been established on top of an still existing structure. Also the success in terms of research excellence is mixed. Though the amount of scientific publications drastically increased, the proportion of citations in high-quality journals still stagnates. This is argued on the other hand to be to great deal being due to the nature of interdisciplinary and more impact and output-oriented research that does not easily fit into traditional lines of publications. Another argument in favour of the ASU as a success model is that it simultaneously manages to increase both, its education capabilities - with the number of intakes doubled between 2002 and 2014 – as well as its amount of research performed, measured in an increase of research between 2002 and 2014 by the factor of 3.5 %. Altogether the ASU provides an example of how a university initiated a re-design process that led to positive developments among all three corners of the KT, though again, the concept at such was not explicitly used as a guiding principle.

*Source*: Crow, M. M.; Dabars, W. B. (2015); Fischman, J. (2014); ASU (2016): https://newamericanuniversity.asu.edu/about/design-aspirations; Download: 16th November 2016.

### *The role of public research institutions (PRIs) in the Knowledge Triangle*

Beside universities public research institutions (PRIs) serve in many countries as an additional pillar in public sector research. Their share in intramural R&D spending has been decreasing in past decades in many OECD countries (OECD (2011)). This is due to a variety of reasons, such as shifts in government funding from PRIs towards HEIs and restructurings of the public research sector by mergers of institutions und HEIs (e.g. in France or Denmark in the recent past). But they remain important actors in some national innovation systems, as dedicated research providers with unique selling points; e.g. providing services in close relation with the business sector, being highly specialized niche-players in certain scientific areas or allowing for long-term strategic research projects (e.g. space projects). Due to a great variety of institutional types among OECD countries, finite typologies of PRIs have to be treated with care. The

OECD innovation policy platform provides a useful, but broad characterization of 'ideal' types of PRIs (see Table 2.1).

**Table 2.1. Typology of public research institutions (PRI)**

| Type | Attribute | Orientation |
|---|---|---|
| Mission Oriented Centres (MOC) | Owned and sometimes run by government departments or ministries at the national or sub-national level.; e.g. NASA | Perform public research in defined thematic areas; support public decision making. |
| Public Research Centres and Councils (PRC) | Multi-Disciplinary, large Organisation with a significant share in public R&D funding; e.g. Max-Planck-Gesellschaft | Perform (and sometimes fund) public scientific and/or applied research in several field. |
| Research technology organisations (RTO) | Often in the semi-public sphere (although some are owned by governments); private not for profit. Also known as industrial research institutes.; e.g. Fraunhofer Gesellschaft, TNO | Link between public sector research and private innovation; knowledge transfer into business sector and society. |
| Independent Research Institutes (IRI) | Semi-public; founded under different legal forms and ownership structures (e.g. run by HEIs); often temporarily, at the boundaries between the public and the private sector research; e.g. COMET-Centres | Perform basic and applied research focused on issues or problems, mostly as shared activities between public and private sector institutions. |

*Source:* Polt and Unger (2016) adopted from the OECD Innovation Policy Platform: http://www.oecd.org/innovation/policyplatform/48136051.pdf; Downloaded at 06.09.2016.

This broad typology also indicates why PRIs have to be considered as important actors in the KT: first because they act at the intersection between the public academic and the private sector, according to their specific function to provide applied research; second, because they provide career opportunities for researchers in a specific, not solely academic, not typically market-oriented environment. Whereas Table 2.1 takes an *ownership* perspective in the classification of different types of PRIs, Table 2.2 takes a more *functional* perspective that also highlights several transmission channels of where PRIs might be engaged along the axis of the KT, especially between research and innovation, but also between academic institutions and PRIs between education and innovation such as through the mobility of researchers.

**Table 2.2. Functions of PRIs**

| Function | Example of Activities | Rationale |
|---|---|---|
| Fundamental/ strategic research | • Fundamental research in particular in areas considered to be of strategic importance, e.g. defence / security, nuclear energy, public health.<br>• Long-term studies | • Improbability that enterprises or universities would undertake the work in sufficient breadth/depth, inter-disciplinarity, with sufficient continuity.<br>• Need to combine basic and applied work and to ensure "knowledge integration", i.e. marrying knowledge from own and other sources<br>• complementarity with university research (link-function)<br>• Scale of the investment required for critical mass (people, facilities, etc.).<br>• Public security interests (in strategic or sensitive areas).<br>• Specialised training and skills (perhaps a benefit rather than a rationale). |
| Technological support to economic development | • Contract research services to industry<br>• Collaborative research with industry<br>• Long-range, foresight-oriented technological research (*speculative research*)<br>• Technology "extension": support diffusion and adoption of existing technologies<br>• Market intelligence services,<br>• Technology matching services | • Compensate market imperfections related to cost and risk<br>• Accelerate and broaden technology diffusion. |
| Supporting public policy | • Fundamental and precautionary research, e.g. environmental policy, public health, food safety, sustainable development<br>• Ex-ante policy design and impact analysis<br>• Ex-post surveillance and monitoring of the implementation of policy, e.g. pollution, seismic survey<br>• Expertise | • Impartiality (including the need to separate monitoring and control functions from advocacy functions)<br>• honest broker of policy alternatives<br>• Requirement for resource-/time-intensive expertise (i.e. more than occasional or one-off expertise)<br>• Responsibility and accountability |
| Technical norms, standards | • Pre-normative research<br>• Implementation monitoring, e.g. metrology<br>• Certification (and certification of certifiers) | • Impartiality<br>• Public security based on independence |
| Constructing, operating and maintaining key facilities | • Big infrastructure (e.g. accelerators, research reactors, botanical gardens, large computing facilities).<br>• Large, unique, dangerous etc. collections.<br>• Large, long-term data collections | • Potential market failure: 'Cost beyond the resources of other players'<br>• Security and safety (physical concentration, accountable management) |

*Source*: Polt and Unger (2016) adapted from EURAB (2005), Gulbrandsen (2011), EARTO (2005), Pielke (2007).

### *2.2.2 Private companies and the role of the business sector*

The perspective of the business or private sector in a KT framework significantly differs from public institutions and public innovation policy makers. Generally commercial interest rather than any other societal or political vision is decisive for whether or not private companies might seek interactions and collaborative activities with the public and semi-public sphere (though there is a non-negligible strand of philanthropic activities from the private sector as well).

These interactions run through different channels: First, via skilled people at all levels of education that are the main prerequisite for companies' innovation capabilities. Second, it is publicly produced research, either by universities or PRIs, which directly or - in the case of basic research – more indirectly could be translated into innovations (e.g. Jaffe 1986; Karlsson and Andersson 2005).

The way and the intensity in which private companies might actively engage in collaborations with public research and education activities also determines the inputs that they might provide to these spheres. Table 2.3 presents a list of some direct inputs and indirect spillovers from the private sector, based on indicative examples from the case studies of this project. Although in the literature the contribution of HEIs to innovation and private sector activities is the usual starting point for analysis, this overview highlights the various potential inputs and spillovers in both directions.

**Table 2.3. Spillovers from private sector to academic research and education**

| | |
|---|---|
| **Direct inputs with respect to research** | • Provision of funds for R&D and innovation activities of public institutions: external funds from companies provide an increasing source, especially for R&D activities in university's budgets in many OECD countries, also influencing universities capabilities and shaping their profiles in the form of e.g. competitive research grants and prizes, endowed chairs or competitive programmes, run either by the company itself or by intermediaries such as private foundations<br>• Companies' engagement as co-funding or in-kind contributing partners in public programmes, such as collaborative R&D projects, cluster- or centre programmes etc.<br>• Participation in basic funding of HEIs, e.g. via donations or investments in research infrastructures |
| **Direct inputs with respect to education** | • Grants and scholarships for students<br>• Collaboration with HEIs in terms of hosting students as part of their professional education, e.g. via internships, the co-supervision of pre-scientific and scientific thesis, or part time host of young researchers in collaborative forms such as Industrial PhD projects, doctoral colleges or European programmes such as the Marie-Sklodowska Curie Actions<br>• Engagement in the development of curricula<br>• Guest lecturers.<br>• Participation in basic funding or even founding of HEIs, especially of universities of applied sciences or institutions with professional or technical specialisations, according to specific needs of companies at a location (e.g. TU/e in the Netherlands or 'new universities' in Sweden). |
| **Indirect spillovers with respect to research** | • Entrepreneurial ecosystem: the existence of an entrepreneurial ecosystem in the surrounding of HEIs (i.e. a vital variety of companies, either MNUs or SMEs) is crucial for university's attitude and those of its individual members towards engaging in entrepreneurial activities, e.g. by the a kind of 'entrepreneurial spirit', the existence of commercialization and start-up know how and capital and an explicit or implicit orientation towards businesses' needs.<br>• Companies' needs may implicitly influence the research profile of HEIs, i.e. by pointing at specific challenges and future needs that call for solutions.<br>• Companies act as absorber and users of publicly produced knowledge: this may help supporting the justification of public funds in R&D. |
| **Indirect spillovers with respect to education** | • Needs of the labour market serve as indication for the design of education programmes,<br>• Graduates may still be connected with their alma mater e.g. via alumni clubs or as donators, and serve as a basis for future networks of young graduates. |

*Source*: Polt and Unger (2016).

### *2.2.3 Public authorities*

The role of higher education institutions for economic and social development as drivers of human capital and skills development and as actors in national and regional innovation systems is meanwhile widely recognized in policy making. The term 'Knowledge Triangle' gained importance especially in the context of European policy strategies according to the targets formulated in the European Union's 2020 Strategy for smart sustainable growth[6], where the efficient linkage of research, education and innovation is seen to be a key prerequisite to tackle societal challenges. In 2009 the Council of the European Union pointed out the "*... need for improving the impact of investments in the three forms of activity – education, research and innovation – by systemic and continuous interaction"*.[7] Hence, the KT is not a finite concept, but should rather serve as an orientation framework, directing the attention of the actors towards the effective linkage between education, research and the business sector. Policies in line with this framework should promote the extension of academic cultures beyond research excellence and teaching towards innovation and contributions to the economy and society. Strong emphasis, besides engaging HEIs in applied research and commercialisation activities, was put on the role of education to provide relevant capabilities such as skills, innovative and entrepreneurial spirits. In their *Agenda for Europe's higher education systems*, often referred to as 'modernisation agenda', the European Commission calls for a greater variety of study modes to allow for flexible and personalized learning possibilities, quality checks for education programmes, the promotion of active labour market support for graduates and new principles for innovative doctoral trainings.[8]

Due to the great heterogeneity of formal responsibilities of governmental and administrative entities, it is not possible to classify the role of public authorities in the KT in a common, one-size fits all, framework. Differences exist for example in governance and financing of higher education institutions, e.g. depending on whether this is anchored at national or sub-national level (with Germany or Spain as examples for a highly decentralized system). Other differences occur according to the degree of autonomy of institutions and the degree of automatism in funding schemes according to the application of formula based or contractual schemes (see next section).

From an innovation policy perspective, differences may occur regarding to whether innovation might be formalized in the responsibilities of a certain ministry or whether innovation is considered as guiding principle in a variety of concepts, funding schemes and institutional targets that are in the responsibilities of several ministries. Another challenge that makes it difficult to attribute responsibilities of public authorities to certain bodies is the growing importance of challenge-oriented policy approaches (e.g. EU's formulation of the grand societal challenges and their embedding in the current research framework programme HORIZON 2020) that take a topic-oriented perspective (e.g. energy production, mobility etc.) differing from the activity related approach that is applied in the KT framework. Hence, different configurations of KTs with different institutional actors and responsible governance authorities might be observed in different topics.

That said, in general terms the role of public authorities (ministries, regional and local administrations) in the KT could be depicted along the following broad lines:

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6 EUCO 13/10.

7 Council of the European Union (2009): Conclusion of the Council and of the Representatives of the Governments of the Member States, meeting within the Council on developing the role of education in a fully-functioning knowledge triangle; Note 14344/09; Brussels, 20 October 2009.

8 EU Commission (2011): Supporting growth and jobs – an agenda for the modernisation of Europe's higher education systems; Brussels, 20.9.2011, COM (2011) 567 final; p. 7.

- Provision of a legal and regulatory framework for public sector research, education and innovation activities based on an attribution of duties to its responsible bodies, as well as for the private sector, including norms, standards, regulations etc.;
- Provision of funding for higher education, public sector and private sector R&D and innovation activities both directly as well as via funding intermediaries such as councils, public agencies and foundations also by indirect mechanisms like tax incentives (*supply side policies*);
- Encouraging of innovation via demand side policies, i.e. innovation oriented public procurement;
- Absorption and use of high skilled human resources, research and innovation outputs;
- Defining thematic or technological priorities that serve as medium to long-term orientation for funding as well as for the orientation of activities of public and private actors (see Mazzucato (2013).

In trying to integrate and to coordinate the activities within the KT, public sector administrations are confronted with a variety of challenges (see Box 2.2).

**Box 2.2. Challenges of public authorities**

- Embedding the entrepreneurial culture throughout the higher education institution
- Involving students as co-creators of knowledge and as part of the innovation system
- Creating rich learning environments for talent development
- Quality assurance and recognition of new skills development
- Taking an interdisciplinary approach in higher education research, but also as guiding principle for concepts and policies targeting for examples EU's Grand Societal challenges
- Developing academic talent
- Internationalization as a way of improving institutional practice
- Implementation of flexible management models
- Transforming working environments – widening access
- Embedding evaluation and monitoring of the impact of activities related to the KT in the university strategy
- Smart specialisation as a policy focus for KT activities
- Taking the longer-term vision for change at the institutional level
- Incentives and funding structures
- Engaging with the national policy environment across the areas of research, education, enterprise and innovation

*Source*: Markkula (2013), p. 18.

More general developments that serve as challenges for public authorities, affecting research and innovation policies, are the increasing globalisation of research, following the globalisation of value chains, goods and services as well as challenges that call for global coordination, e.g. regarding environment, energy production and resource management. Whereas earlier concepts of that type where focusing on technological sectors, new horizontal approaches refer to societal needs and challenges as guiding principle for the definition of prioritized areas for intervention. These mission or challenge-oriented approaches therefore not only call for the integration of actors along defined priorities but also for an integration of policy spheres that need to be aligned according to these objectives. Furthermore, they may also impact the forms of education by focusing on areas of great needs (e.g. MINT) or the integration of innovation as guiding principles that may go beyond tertiary education, calling for an integration of the total education system, as e.g. performed in the Dutch Technology Pact. From the perspective of transnational effort required to tackle challenges (as emphasized in the current EU Research Framework Programme HORIZON 2020), the KT might be including actors in a cross boarder perspective

(as it is already attempted e.g. in the model of Knowledge and Innovation Communities (KIC) of the European Institute for Innovation and Technology (EIT)[9]).

The following public policy initiatives at national level, aiming to increase innovative and economic capabilities by emphasizing not only research and research collaboration between academia and industry, but also by promoting education in targeted areas of national interest at all educational stages, serve as examples for a holistic approach of the public sector in terms of the KT (Boxes 2.3 and 2.4).

**Box 2.3. The Dutch Top Sector Initiative**

In 2011 the Dutch government launched a policy initiative to strategically align public resources for R&D and innovation along nine so-called top sectors. This approach aims to target future challenges and optimise Netherlands' competitiveness and prosperity based on the enforcement of knowledge and innovation. Stakeholders along the KT of the business sector and tertiary education and research should join forces, exploring new markets, inventions and products. The nine strategic priorities comprise agro-food, horticulture and propagation materials, high-tech systems and materials, energy, logistics, creative industry, life sciences, chemicals and water. They were identified as the most promising and competitive areas of the Netherland's economy, together accounting for over 80% of business sector R&D expenditures, 55% of total exports but only up to 30% of value added and employment. Science-industry collaborative research should be encouraged in these areas, especially targeting the participation of SMEs. The sectoral-approach is chosen for two major reasons 1) to overcome existing barriers between several government departments and ministries involved and 2) to leverage private investments through a close cooperation of public and private actors in the respective fields. The total estimated budget is about EUR 1 – 1.1. billion each year in 2013-2016, mostly including existing finance instruments (from ministries, NOW as well as resources of PRIs and HEI, private sector) that will be streamlined along the priorities. This includes also a tax credit scheme for research and development (R&D).

The definition of the top-sectors was very much in the hands of the so-called top teams including high level representatives from industry, public research and the government. The top teams formulated strategic agendas for each of the top sectors. Responsible for the implementation of the strategic agenda are the so called top consortia for knowledge and innovation (TKI), comprising public-private partnerships, including businesses and higher education and research institutions. The implementation of the TKIs is supported by the government in the form of allowances to reimburse private partners for their engagement

Beside of strategic funding for collaborative research and innovation activities, the top-sector initiative also comprises with the so-called *Technology Pact*, targeted measures and funding along all stages of the education cycle, to improve skills and human resources in areas related to the Top Sectors.

The progress and success of the measures within the framework of the Top-Sector Initiative are collected on the basis of a separate set of indicators developed by the Dutch Statistical Office on a 2-year basis, covering the macro-economy, enterprise development, employment characteristics, innovation performance and education output. The Advisory Council for Science, Technology and Innovation (AWT) is also entrusted with the evaluation of the initiative. The Dutch Top-Sector Initiative is thus an example of a national commitment to thematic prioritization, including concrete financing objectives and measurable success indicators. However, there are also critical voices, for example with regard to the focus on existing strengths and not on their potential future viability. Furthermore, SMEs are largely excluded from the activities of the top sector initiative due to the high resources required.

*Source*: Polt et al. (2015) based on OECD (2014): Reviews of Innovation Policy: Netherlands.

9 https://eit.europa.eu/.

**Box 2.4. Australia's National Innovation and Science Agenda (NISA)**

As a response to observed obstacles in its innovation capacity regarding the effectiveness of industry-research collaborations, the support for entrepreneurship and a lagging venture capital culture, school students' STEM skills as well as government support for innovation, the Australian Government launched a National Innovation and Science Agenda in 2015. With a dedicated budget of AUD 1.1 billion a year, actions should be undertaken along four key pillars: i) Culture and Capital, ii) Collaboration, iii) Talent and skills, iv) Government as an exemplar.

Key actions of the 'Culture and Capital' pillar comprise a new tax model, aiming to favour risk taking and innovative companies as well as co-investments for commercialisation activities from Australia's public innovation fund CSIRO, including incubators.

The second pillar emphasizes the promotion of collaborations between universities and the business sector by several new measures, including investments in and built-up of large, world-class research infrastructures and cluster activities. Furthermore, HEIs performance in collaborations activities should become on factor for the allocation of public block funds, first by reserving dedicated budgets, second by the development of a respective monitoring scheme to be implemented between 2017 and 2018.

The 'Talent and Skill' pillar aims to better equip young Australians in the fields of STEM subjects and ICT. Activities include Summer Schools or so-called STEM partnerships to bring scientists and professionals in the classrooms. Other activities comprise the support for women in the areas of ICT and STEM as well as the attraction of talents, skill and young entrepreneurs from abroad via a new visa scheme.

The last pillar should emphasize innovation via direct government activities, including innovation oriented public procurement or the digital provision of public services and information.

Though it is too early to make any assessments about the impact of this agenda, it serves as another good example of an holistic government perspective in policy planning, simultaneously promoting actions along each axis of the KT as well as at their intersections.

*Source*: Australian Government (2015): National Innovation and Science Agenda.

## 2.3 Governance models and policy tools for the support of Knowledge Triangle activities

Whereas policy fields are often treated separately from an economic perspective, e.g. industrial policy, education policy, innovation policy – which may cause a 'silo-thinking' – the KT calls for an integrated approach of policies targeting the three corners education, research and innovation. In the following respective mechanisms in higher education policies, instruments to improve industry science relations, as well as aspects of evaluation in the context of the KT will be discussed.

### *2.3.1 Funding and governance for higher education institutions*

According to the role of HEIs as key actors in the KT, governance mechanisms in the HEI sector are crucial for shaping the KT. The design of governance structures and funding mechanisms is an important determinant how higher education institutions may position themselves in the KT, as they provide both incentives and barriers at the level of individual researcher as well as the institutional level. Several developments took place in the past two decades in many OECD countries that had direct effects on HEIs engagement in KT activities. These developments include both changes in the regulatory framework as well as in steering and funding mechanisms of public authorities, namely:

- Increase in HEIs institutional autonomy, regarding e.g. the usage of funds, the engagement in cooperation, recruiting & HR development, the development of curricula etc.;

- Introduction of performance-based funding schemes for the allocation of basic public funds comprising contracts, agreements, formula and indicators based schemes;
- Increase in external (competitive) funding, both by public and private sources;
- Institutional cooperation and mergers.

These developments will be described in the following section.

*University autonomy and performance-based funding*

The increase in universities' autonomy, by means of legal and institutional independence in the linkages with public authorities, was accompanied by the introduction of performance-based elements in allocation of basic public funds to universities in many OECD countries, according to principles of new public management. *"Performance-based funding is to be understood as type of funding were the (public) budget of a higher education institution varies with the performance of the institutions."* [De Boer et al. (2015)]. Hicks (2012) pointed out six major rationales for the gaining importance of performance-based elements:

- Incentivise increased productivity
- Replace traditional command-and-control systems with market like incentives
- Incentivise a stronger service orientation
- Devolution of administrative autonomy to higher education institutions
- Contracting services
- Enhance accountability to outputs and outcomes provided

De Boer et al. (2015) found institutional profiling, i.e. a strategic diversification of the higher education systems based on individual institution's strengths, to be another intended impact of performance-based funding schemes. Several recent studied surveyed the structure of performance-based schemes in European and OECD countries (e.g. Pruvot et al. 2015, de Boer et al. 2015, Hicks 2012, Niederl et al. 2011) finding a great variety in design and target variables. Instruments of performance-based funding comprise formula-based schemes, performance agreements and contracts as well as combinations of these elements which tend to be most frequent. Furthermore instruments could differ regarding the point in time at which performance is measured.

Formula-based funding schemes typically apply an output-oriented, ex-post perspective on past periods that provide the justification for the allocation of funds. Indicator schemes can target teaching and research performance as well as 'third mission' activities. The latter is often approximated by the amount of third party funding or cooperation activities. According to the aforementioned studies, frequently used indicator dimensions cover: i) the number of graduates, ii) number of exams passed or credits earned by students, iii) study dimensions, iv) social mix of students, v) average study duration, vi) number of PhD graduates, vii) research productivity, viii) research performance in terms of the amount of competitive projects, ix) third-party income, x) revenues from commercialisation activities (patents, licence income). In many countries typically mixed systems of performance indicators are applied for education and research (e.g. Denmark, Sweden, Australia), to a different degree also in connection with historical path dependencies.

Other than formula-based schemes, performance contracts or agreements set targets for future performance, mostly on negotiated basis between the responsible ministry and individual universities. These measures can be characterised as being *soft* or *hard* in terms of their effect on funding when targets

could not be achieved. Performance agreements typically allow for setting strategic targets for institutional development other than those that could be captured directly by technical/numerical quality indicators. That is why performance agreements are especially useful tools for expanding HEIs missions beyond research and teaching activities. Such targets may comprise e.g.: i) increase of HEIs societal and locational outreach and engagement, ii) institutional profile development, iii) improving interlinkages with the business sector and contributing to innovations, iv) increase international connectivity of national R&D. The differentiation between the terms 'agreement' and 'contract' mostly refers to the degree of legal binding, i.e. whether and what type of sanction might be applied by the governing authority if outcomes are not achieved. Though having been installed in many countries in the recent past, in most of them they have the character of supplements to formula- or historically-based schemes, due to their dedicated share of budget (for most EU countries between 1 % and 7 % of block grant allocation according to Pruvot et al. 2015), the power of sanction mechanisms, or the focus of those agreements on specific but not all areas of universities.

Based on an analysis of universities' performance in the Shanghai ranking and patenting output, Aghion et al. (2009) showed university autonomy and competitive funding mechanism to be positively correlated with university output, both in Europe as well as among U.S. public universities. But the application of performance-based funding mechanisms does not only affect performance in universities research and teaching outputs, but also determine their potential to engage in innovation related activities and therefore the full integration in the KT.

The contributions of autonomy and performance orientation on funding for HEIs participation in the KT are mainly twofold: First of all, increased autonomy creates room for manoeuvre for the internal allocation of fund as well as strategic agenda setting and profile development of institutions. Second, as pointed out, performance mechanisms itself may focus on commercialisation and universities' contribution to innovation and other third mission activities, such as societal outreach. But depending on the calibration of such performance-oriented schemes (status beneath other targets, financial resources) there might also be conflicts between the different services of universities, e.g. a crowding out of education against research or vice versa in the competition for limited resources. Polt et al. (2015) observed in an in-depth analysis of the Danish and Swedish innovations systems that, though innovation is high on governments agenda especially in Denmark with a great deal of commitment from the university sector (see Box 2.5), many HEIs feel that this is not properly reflected in funding mechanisms, as they are still focusing on education and excellence in research output. Another tension between universities' missions may occur according to mechanisms such as the Swedish "professor's privilege" allowing for both a teaching exemption for research projects for professors as well as the autonomous ownership of IPRs by individual researchers (Damsgaard and Thursby (2013).

**Box 2.5. The Danish performance agreements: university autonomy and strategic development**

The Danish higher education systems underwent some significant changes in the last decade. Following a decision of the Danish Parliament in 2006 universities and higher education institutions were asked to engage in institutional mergers, based on autonomously determined processes by the respective institutions. The merging process also included public research institutes. This led to a restructuring of the higher education landscape in Denmark from former 12 universities and 13 research institutes to nowadays 8 universities and 3 research institutes. As an incentive for institutions to engage in the merger processes, public funding for the HEIs sector was increased significantly. Danish universities are granted with a high degree auf institutional autonomy. Together with an overhaul of the university landscape also financing and governance mechanisms have been further developed to put stronger emphasis on competition between institutions as well as on enlargement of universities' by innovation and societal outreach. Competition should be promoted by the introduction of performance indicators for research, aside the in the 1990s established Taximeter scheme for the allocation of education funds. The second pillar - widening of universities' task, anticipating innovation, the interaction with the surrounding the eco-system or the contribution to societal developments and hence the participation in KT activities – should be encouraged via individually negotiated performance agreements between each university and the government. Though not having the status of legally binding contracts these agreements are seen as important instrument in nudging institutions towards a broader understanding of their mission and to contributing to profile development of these autonomous institutions. As signatories of the agreements, university could be held accountable by the minister for their implementation.

Being first implemented in 2000 on three year's basis, scope and design of the performance agreements has been evolving since then, from comprehensive and process-oriented planning documents towards leaner and more strategically oriented mission statements, with a limited number of measurable targets. The definition of these targets is part of the negotiation process; the ministry might define strategic areas of national interest. The targets that were defined for the period 2012–14, though not explicitly ascribed to, could be interpreted as an integration of the KT as a guiding principle for the understanding of universities' role, as they were:

1. Increase the quality of degree programmes, both from an individual student's as well as from a labour market perspective,
2. Better cohesion in the educational system, i.e. improving the transition between different institutions,
3. Faster completion times,
4. Increased innovation capacity through knowledge exchange with society.

Though the perception of universities in Denmark about the performance agreements is on principle positive, as they have become 'smart' and more specified pushing universities to think more and act more strategically, tensions could not be neglected. First of all, the connection between incentives provided via the funding mechanism, emphasizing quality and output in research and education, and targets specified in the agreements is still indirect, actually limiting universities' capacities to emphasize innovation and societal outreach. Furthermore, the emphasis that is put on measurable targets raises apprehensions by the academic community that this might limit scientific independency. Finally, the engagement of external actors in the formulation of institutional targets is still limited and only indirect – university boards comprise external members – though this would be an important prerequisite for actually improving universities' societal outreach.

*Source*: De Boer et al. (2015), Polt et al. (2015).

#### *2.3.1.1 Institutional change of higher education systems*

The increase of university autonomy and the introduction of performance-based funding schemes were accompanied by a strive towards a consolidation of the public research sector by mergers of HEIs as well as of HEIs and PRIs, especially in Northern Europe (e.g. Denmark, Finland) but also in France. While cost saving and efficiency reasons were often cited, Pruvot et al. (2015) showed that they are just of minor importance. In fact the aim to create "critical masses" in areas of research and education, as well as strives for improvements in quality were identified as main drivers of these developments. Beside this expected gain in quality, another perceived positive effect is the reduced complexity of the public research system in terms of the number of institutions. Especially the integration of PRIs in universities might help companies to improve access to public research services as the landscape of institutions and potentials for connections

becomes clearer, as it has been the case in Denmark.[10] Another example for a structural overhaul of a university landscape in the past decade is France, as outlined in Box 2.6).

**Box 2.6. The French Pôle de recherche et d'enseignement supérieur (PRES)**

The French higher education system underwent some significant reform processes in the past decade. One of the most profound was the implementation of so-called Research and Teaching Centers (*Pôle de recherche et d'enseignement supérieur*, PRES) by pooling of activities and resources from universities, grand écoles and public research institutes at a location, as a requirement resulting from the 2007 autonomy reform. The idea was to improve coordination at joint sites and contribute to the development of internationally visible critical masses by pooling resources in specific research areas. This is in line with a new logic in French research policy which promotes, unlike, for example, the German Excellence Initiative, locations ('sites') rather than individual institutions.

The interaction within a PRES could take two forms: (a) a formal mergers of institutions; or (b) the joint establishment of a research institute of public law (EPCS) in research in certain areas. Joint activities cover both, research as well as training at PhD and master level. In addition the PRES served as joint platforms for the dissemination of research results aiming to contribute to the international visibility of respective locations. The PRES had its own administration, headed by president elected by all member institutions. The aim was to promote co-operation between different types of institutions, thereby contributing to the coherence in the provision of services and, against the background of different legal public entities with different missions being in place in the French's research system. The establishment of a PRES was the prerequisite for universities to obtain the new autonomous rights according to the University Act of 2007, comprising autonomy in the internal allocation of public funds, human resource planning and the strategic development of research and education fields. Furthermore, this was also conditional for becoming eligible for funding from the 'programme for future investment' (*Programmes des investissements d'avenir*, PIA), implemented in 2010 as French' model of an excellence initiative, with an estimated public budget until 2020 of € 35 billion.

By 2012, a total of 26 PRES were established, including a series of institutional mergers, such as the new Universities of Strasbourg, Grenoble and Lorraine. With the reform of the Universities Act in 2013, the PRES were transferred into so-called Communities of Universities and Institutes (CUEs) in order to improve coordination in teaching. The CUEs and the *Ministère de l'Education nationale, de l'Enseignement Supérieur et de la Recherche* (MENSR) now also conclude multi-annual performance agreements, in which their specific activities are regulated.

*Source*: OECD (2014): Reviews of Innovation Policies – France; OECD Publishing.

*2.3.1.2 Competitive funding for higher education institutions*

Accompanying the aforementioned transition in universities' role an increase in shares of third-party or external (non-governmental) funds in universities' budgets could be observed in many countries all over the world. This is on the one hand attributable to the growing importance of competitive grants allocated by the public sector and its intermediaries. On the other hand, with universities increasingly engaging in collaborations and contractual research activities, revenues also increasingly stem from the private side.

The financing of university research by third-party funding has different implications depending on the source of the funds: Public programmes are designed to follow different strategic targets (i.e. increasing excellence in a certain area) or structural objectives (i.e. improving industry-science relations), adding to those that could be addressed by performance-based and competitive mechanisms in basic funding. Depending on the targets, structures may be either bottom-up or top down-oriented in defining thematic areas and comprise either basic or applied research. Another distinction is whether projects, individuals or institutional arrangements (e.g. partnership structures with the business sector) or infrastructures are the focus of actions.

[10] Polt et al. (2015).

Third party funds acquired from private sources, especially from industry partners are often used as indicators of for the quality and amount of knowledge transfer taking place between the academic and the private sphere. In some countries (e.g. Denmark, Sweden or the US) also private foundations, owned by philanthropic investors or companies, play in important role in funding R&D and tertiary education. From a KT perspective potential conflicts that can occur due to different objectives of public and private funding have to be identified and pointed out. In some areas, as it is the case e.g. in the Danish' Life Science Sector (see Polt et al. [2015]), private money may be the dominating source of funds for HEI' research but also education activities (especially regarding PhDs). Thus, it poses the threat to reduce public sectors steering abilities in the thematic portfolio of academic research as well as the capabilities for orchestration between the spheres of the triangle by being "crowded out" in the definition of strategic areas.

Another potential pitfall regards the overhead costs caused by competitive funds, both from public and private sources that only seldom are covered sufficiently. With an increase in external funding also an increased share of universities' basic funds are tied to co-financing requirements. This leads to diminished capabilities for strategic actions by the universities' management, regardless of their degree of formal legal independence in the usage of funds (see e.g. OECD 2016).

### *2.3.2 Industry-science relations and knowledge transfer*

Various studies have analysed and discussed transfers channels, interactions modes and policy instruments of how knowledge transfer from the academic sector into the society, companies and between institutions of the same type may take place (e.g. recently OECD (2013); Perkmann et al. (2012); Arundel et. al (2013); Mathieu, A. (2011). In a broad classification, transfers channels could be differentiated between those providing access to research and education outputs and those stemming from university's own entrepreneurial activities also being often summarized as commercialisation activities. Furthermore, more informal linkages such as individual networks have also be identified as being often a key prerequisite for later formal cooperation. Table 2.4 gives an overview about those commonly identified transfer channels as well as related modes of their formalisation and policy support structures.

**Table 2.4. Knowledge transfer and commercialisation channels and interaction modes**

| Transfer Channel | Mode of Interaction and support instruments |
|---|---|
| **Informal Outreach activities** | Conference Participation |
| | Formation of social relationships and networks |
| | Inter-sectoral mobility of people (students, researchers) |
| | Publications |
| **Research & Education Collaboration** | Cooperation in education: firm's participation in curricula development, share education facilities (e.g. PhD programmes, Internships) |
| | Cooperation in research in inter-organisational arrangements and collaborative facilities (research centres, labs, cluster programmes, platforms etc.), |
| | cooperation in research on project basis |
| | Shared research facilities |
| | Academic consultancy services |
| | Joint Publications |
| **Commercialisation and Entrepreneurial activities** | Patenting and licensing activities: TTOs |
| | Public-research spin offs and academic start-ups |
| **Other** | Joint development of norms and standards |
| | Joint provision of consultancy for public policy makers e.g. via scientific councils or consultations on EU level (EUA) |

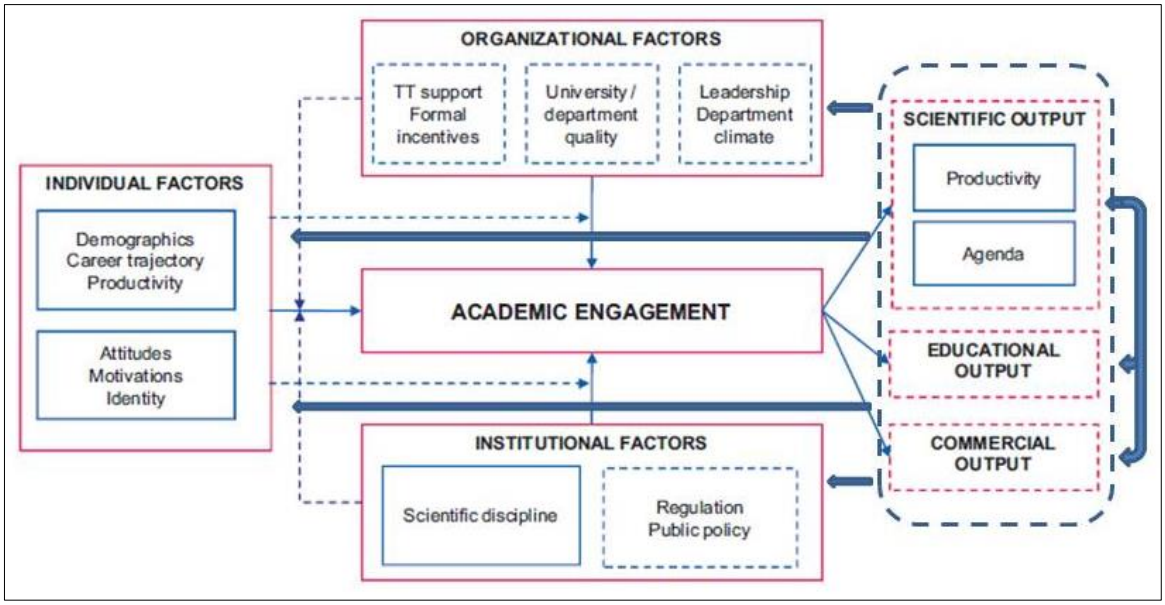
*Source:* Adopted from OECD (2013); Mathieu, A. (2011); Perkmann et al. (2012).

The importance of these channels as well as institutional capabilities to engage in these type of activities are determined by institutional characteristics such as scientific and educational areas, the degree of autonomy and management capabilities of the institution, departments, faculties and individuals as well

as the shape of the surrounding environment, comprising potential partner companies and institutions, incentives by the public funding system and political strategies.

Whereas these channels typically refer to a mono-modal perspective in the transfer of knowledge, i.e. the provision of research outputs by separated modes of outreach activities; from the KT perspective externalities between several transfer channels and spillover effects, stemming from the external outreach, on universities functions in research and teaching have to be incorporated. Experienced researchers or faculties in contractual and collaborative research activities may provide important know-how for their students and their further academic career. A vital start-up culture may be a fruitful seed for emphasizing entrepreneurship in teaching curricula. The engagement in collaborative activities may also benefit universities research reputation, signalling high quality and reliability, which may lead e.g. to an increase in external resources as well as to an attraction of academic talents. These are just few examples, but depending on the specific characteristics of individual universities' mechanisms to engage in knowledge transfer and the incentives and capabilities of the surrounding eco-system, many more are identifiable. Figure 2.2 gives an overview about several factors and capabilities of individuals and their institutional environment on the left hand side and the centre, determining the knowledge output on the right hand side. Hence, we have added the externalities and spillover effects caused by the active engagement in those transfer activities on capabilities and attitudes of the performing institutions.

**Figure 2.2. Analytical framework of external engagement by academic researchers**




*Source:* Own adoption based on Perkmann et al. (2012).

From a policy perspective of encouraging the KT, these independencies between several transfer channels and universities internal structures have to be taken into account. Beside positive effects of increased capabilities and external knowledge acquisition, also potential conflicts may arise with the spheres of research and teaching. In that respect, the understanding of industry-science relation and transfer mechanism in the context of the KT has to be extended from a mono or bi-directional flow of knowledge on the level of projects towards the promotion of creating of innovative milieus and the joint shaping of agendas that aim to integrate all three spheres of the KT. Activities of this type typically comprise mid- to longer-term collaborations between academic and external partners both from the public and private sector. Examples in this vein include Excellence Centre Schemes with successful examples in Sweden or Austria, aiming to translate basic research outcomes into applicable knowledge and solutions for companies. Other

instruments such as Cluster Programmes or Development and Innovation Platforms put greater emphasis on applied research and innovation. Another important function of such instruments is the engagement of students and/or PhDs in research and development projects with companies or on behalf of public sector interests. The Swedish' Strategic Innovation Area Initiative (SIO) as well as the Danish' Innovation Networks serve as further examples in this vein (Box 2.7 and 2.8).

**Box 2.7 The Swedish Strategic Innovation Area Initiative (SIO)**

The Swedish' Government Bill for Research and Innovation 2012 stated the need for a new instrument to promote bottom-up, challenge-oriented innovation processes based on long-term and deep collaborations between universities, research institutes, industry and SMEs, the public sector, civil society and other stakeholders. As a consequence, VINNOVA was assigned for the implementation of the so called Strategic Innovation Area Initiative (SIO), with a target amount of funding of SEK 225 million (€ 24 million) for the period 2013 – 2016, including budgets for the Swedish Energy Agency and the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas).

The implementation of strategic innovation area was a step-wise process, very much aligned with those of the ERA-NET scheme a European level, with the aim to pool resources form different partners for joint projects in strategic areas. In a first step, VINNOVA called for the implementation of so-called Strategic Innovation Agendas (SIAs) by consortia's of different stakeholders, spanning the strategic and topical frame for joint activities. Three waves of calls for SIAs have been conducted. For this action, consortia received seed funding from VINNOVA. In second step, VINNOVA decided on whether these SIAs might be suitable for the development of so-called Strategic Implementation Programmes (SIPs), which then receive funding for a range from three to nine years. The SIPs lay out the implementation process for the respective SIA, i.e. the development of calls for project proposals and the monitoring process for projects results. The set-up of the SIP is again a collaborative process, normally designating a project coordinator and a supervising board of directors. Until October 2015, 16 SIPs have been selected. Though most of the SIP coordinators are located at universities, some of them are also coordinated by sectoral associations, such as the Association of Swedish Engineering Industries, the Swedish Steel Producer's Association or the Swedish Air Transport Society. Though a broad range of areas is covered by SIPs, the largest part (75 %) of funding in the first wave of calls for SIAs was concentrated on view areas, namely mechanical engineering, materials technology, electrical engineering, ICT and other engineering technologies.

Since the initiative is still ongoing it is too early for conclusive assessments on its impact and functioning. In a first assessment stakeholders of the process reported, that the SIO was first of all supportive in expanding their existing networks, stimulating the creation of new innovative milieus. But also tension were raised, concerning the adequacy of the term "strategic" against the background of 16 different, to some extend very specialized, initiatives implemented so far, that provide reason for the assumption that the initiative supports to a large extend individual and actor's specific interests, rather than objectives of broader societal concern.

*Source*: OECD (2016): Reviews of Innovation Policy: Sweden 2016; OECD Publishing.

**Box 2.8. The Danish Innovation Networks**

The Danish Innovation Networks represent a specific type of cluster policy. Implemented in 2006 by the former Ministry of Science, Technology and Innovation (today's Ministry of Science and Education) their aim is to create joint platforms of companies, universities and research institutes (GTS Institutes), contributing to improve interactions and exchange of knowledge between the different institutions and to increase the innovative potential of the Danish economy. The focus is on companies which have not yet cooperated with universities or research institutes, in particular, SMEs.

Innovation Networks are based on formal partnership agreements between member organizations with a clearly defined economic or technological focus. The involvement of universities is mandatory. In addition, an office has to be established, which is responsible for the development of a common strategy, financial issues and the administration and dissemination of the activities of the network and the resulting projects. The Innovation Networks are financed up to a maximum of 50 % by national public funds. The private sector must contribute at least 40 %. This could also comprise in-kind services such as the provision of labour or equipment by participating companies. Furthermore, numerous innovation networks collect fees. Other funds arise from regional and local resources, as well as from the EU structural funds.

The central task of the Innovation Networks is to bring together companies with research institutes and university researchers (matchmaking). This should support the implementation of consortia for project applications in national public and EU funding schemes. Another focus is on networking as well as the exchange of experiences in the respective field through the organization of conferences, educational programmes and workshops as well as networking with international networks. In addition, within the framework of the Innovation Networks, concrete projects for the production of new knowledge, new technologies, products or services under joint financing of individual partner organizations (at least 2 companies, at least 2 universities) are to be developed and implemented. A necessary criterion is that the results of these projects must be of broader societal interest beyond the directly involved companies. Currently there are 23 Innovation Networks in place, covering areas such as energy, environmental technologies, ICT, tourism, production technologies and materials, food production, medical technologies and innovative solutions in the construction and transport sector.

Up until 2011, the Innovation Networks were monitored using annual performance accounts. For that purpose a standardized set of indicators, e.g. regarding the number of events or projects and the institutions involved was developed. Also qualitative assessments on knowledge transfer activities were applied such as a survey among the participating companies on the impacts on their innovation capacity and competence development. Several positive developments were found. The number of companies which have rated participation in an innovation network as positive for their ability to innovate has steadily increased since the introduction of the measure. An econometric analysis conducted for all Innovation Networks in 2011 also revealed a four and a half time higher probability for innovation among participating companies compared to a control group of non-participating companies. In addition, the likelihood of further R&D cooperation with universities and research institutes as well as the participation in other programmes to promote innovation (e.g. the Innovation Fund Denmark) increased. Since innovations networks typically tie together actors at a location, though not necessarily restricted to administrative regions, they are also considered important drivers for regional development.

*Source*: DASTI (2011a) and DASTI (2011b).

### *2.3.3 Evaluation of policy instruments and measures related to the Knowledge Triangle*

The evaluation of the embeddedness of the KT in institutional activities or national policy paradigms is a challenging task, since it is rarely addressed explicitly (with a few exceptions such as the strategic vision of Aalto University, see Markkula (2013)). Any assessment of instruments and measures would have to be elaborated from the implicit structure of applied mechanisms, targets and performance indicators. From a KT perspective, the focus of evaluations of STI-oriented strategies and measures has therefore to be enlarged, beyond the assessment of effectiveness, efficiency, outcomes and outputs as wells positive or negative externalities of measures, towards a broader picture also emphasising the coherence between policies in the field of education, research and innovation.

Evaluations of public programmes, e.g. targeting industry-science relation or university excellence, usually have the form of effectiveness and efficiency analysis, assessing whether specific programme goals or policy targets have been met. Evaluations have to be differentiated from monitoring of developments or performances that are connected with the allocation of funds or sanctions regarding the achievement of agreed benchmarks. Though in many higher education systems a holistic view on HEIs functions is applied already, depicting and assessing their triangular role for research, education and innovation is rarely undertaken. Monitoring systems, whether they apply numeric indicators or contracted milestones are typically emphasizing these topics in a mono-modal perspective, suffering from difficulties of properly addressing spill-over effects and externalities between the spheres.

Acknowledging the difficulties of evaluation and monitoring of systemic relations, the KT concept should not be treated as subject of evaluations by itself, but as a guiding principle for i) the assessment of the outputs and outcomes of institutions, policy measures and programmes and ii) the reflection upon the balance of how the three spheres are represented in the portfolio of public policy measures, i.e. whether there are signs of over-emphasizing each of them financially, regulatory or even rhetorically.

The process to develop and test an evaluation mechanism to be able to assess and incentivise HEIs societal engagement in Sweden, initiated with the Government Bill 2012, can serve as a good practice example of how to actually implement this claim in institutional development (Box 2.9).

**Box 2.9. Evaluating and incentivising HEIs societal engagement: lessons from the Swedish' developmental pilot 2013–2016**

Since 1997 the interaction of HEIs with surrounding society is embedded as an official "third task" in Swedish' Higher Law, referring to a long tradition of societal and economic outreach activities of Swedish' HEIs. Since then, many initiatives, support structures and funding instruments, both on national, institutional and agency level have been implemented to actively support developments according to this mission. Nevertheless, societal interaction in HEIs mission and activities was observed to still be more an add-on to research and teaching as still prevailing core missions and the institutional uptake was depending on a variety of path dependencies and organizational features. As a response the Government Bill of 2012 called for the development of evaluation mechanisms to be able to assess HEIs efforts in terms of performance and quality of their interaction with society allowing for a more strategic allocation of public funds. This should also include the development of new incentive mechanisms. In 2013 VINNOVA and the Swedish Research Council were assigned to implement a process, running until 2016, to develop and test an evaluation model for HEI's societal interaction. The government reserved in total € 21.3 million for this process along the entire period. The process itself comprised three major building blocks:

1. Two pilot calls for dedicated strategic projects to be implemented by single HEIs or consortia of HEIs in 2013 and 2014 with a total allocated budget of € 15.95 million (government funds and VINNOVA top-up); all Swedish HEIs were asked to participate with 27 actually getting funded;

2. A continual dialogue process with HEIs, public regional and national authorities, public councils and agencies as well as interest representations such as the Confederation of Swedish Industries to develop common principles and characteristics of HEI's societal interactions as well as a respective evaluation process; the underlying principle is that societal interaction should not be understood as a one way flow of knowledge or as a top up to teaching and research but as a bi-directional process helping to strengthen relevance and quality of research and education;

3. Two further pilot calls to test the developed evaluation process and assessment mechanisms, focusing on the HEI's strategies and implementations plans as well as on the quality and results of interaction activities with an designated budget of EUR 12.8 million in total; for each of these features 2-3 qualitative indicators were developed to be assessed by an expert panel; to account for the great institutional variety in the Swedish' HEI system, institutions were categorized along six major groups, to avoid one-size fits all approaches in the evaluation process: i) large comprehensive universities, ii) specialized university colleges, iii) university colleges without special domain, iv) university colleges

of fine applied and performing arts, v) new universities, vi) large specialised universities.

The process led to some illuminating insights on the status of ways and quality how societal interaction is performed in the Swedish HEI system. A surprising result was that not only large and specialised universities in the fields of engineering, technology or medicine but also a large number of regional universities gained favourable results in the evaluation pilots. Also a divergence was observed between the amount of favourable evaluations of strategies and actual results of HEI's societal interactions. Examples for initiated projects cover different fields of activities, e.g. improve inter sectoral mobility of researchers, the implementation of strategic collaboration platforms between HEIs, or the built up of an alumni network as a basis for future cooperation in projects. All in all, according to its initial targets, the process led to a stronger peer network of HEIs and a shared and more holistic understanding about the mutual benefits of societal interactions. Some key lessons from the process that might also provide learnings for other countries were :

- The active involvement and dialogue with HEIs on several levels (leadership, departments and faculties, staff and researchers) on that issue is key to get both, a better understanding of the subject as well as higher consensus about the outcomes.
- Initial funding is a requirement to provide incentives for institutional change but already small amounts could have large leverage and mobilization effects on people, activities and organizational learning.
- Evaluation tools can stimulate the organizational development of HEIs but should be sensitive to different institutional types.

Source: Wise et al. (2016).

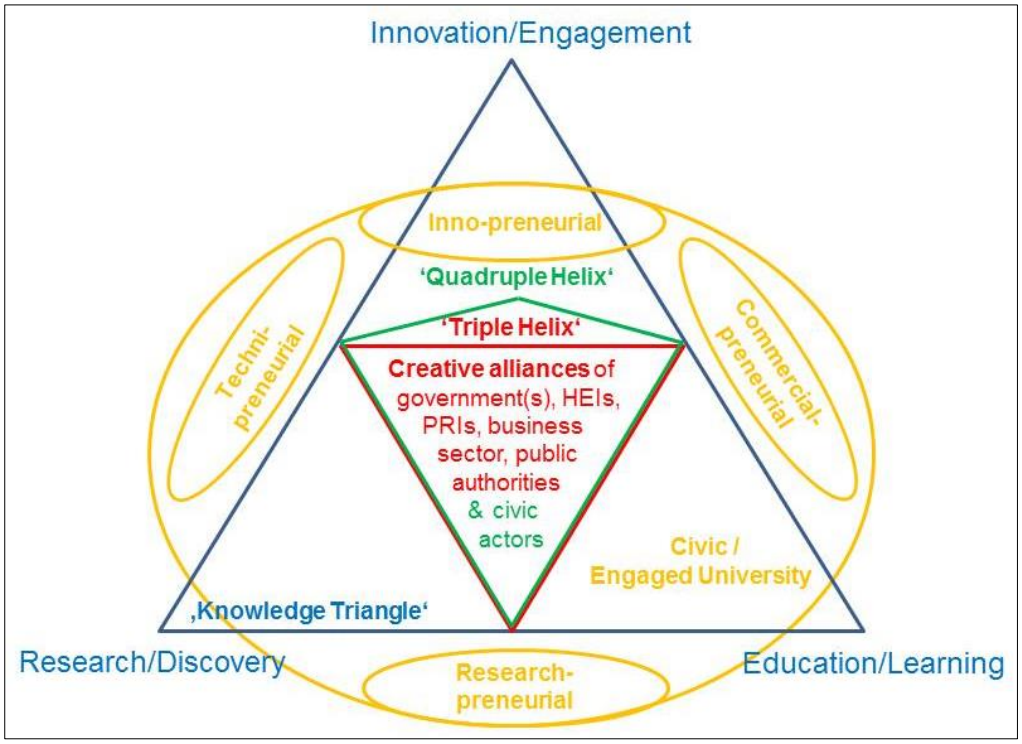
## Concluding discussion

The KT concept was used throughout of the OECD project as a common analytical frame. It addresses in a systemic manner the interactions between actors in the spheres of education, (academic) research and knowledge creation and innovation. Many of the interactions dealt within the KT framework have been also addressed from different angles and perspectives in other analytical frameworks like the 'triple helix', 'entrepreneurial university' and others. As e.g. the Swedish or the Canadian case studies show, many researchers and research performing units at higher education institution are not familiar with the concept of the KT though certainly performing activities along its axis (knowledge transfer, cooperation with companies, education etc.). At least some universities explicitly address the 'third mission', the 'entrepreneurial university' or the 'triple/quadruple helix' as part of their mission.

Though common trends could be identified that are affecting both the attributed role and the behavioural and organizational characteristics of universities, in deriving general policy prescriptions, one should be cautious given the great deal of institutional diversity. Rather policy learning from comparing similar institutional settings and challenges can be aimed at.

**Error! Reference source not found.**Figure 2.3 shows how the KT could serve as integrative framework for the variety of concepts discussed in this chapter that are all referring, with different emphasis though, to a more broader understanding of HEI's role for societal and economic development, and hence as a guiding principle for the development of respective policies by concerning the interrelation the enabling factors, research, education and innovation.

**Figure 2.3. The Knowledge Triangle as an integrative policy framework**




*Source*: Polt and Unger, 2016.

Irrespective of which concept is adopted (KT, 'triple/quadruple helix', 'civic or entrepreneurial university') they all ask for a policy or a strategy that is aware of the interrelatedness of the activities, potential trade-offs and the necessary differentiation in incentives and instruments when addressing the different KT angles and actors. Instruments that affect the independencies between corners of the triangle are still focusing very often on single issues, e.g. education, commercialisation, research interlinkages between academic and business sector etc., rather than applying an integrative perspective on research, education and innovation. Especially contributions of and spillover effects on education are often underrepresented in efforts to improve industry-science relations.

As 'true KT' activities therefore those might be classified that aim at improving the interlinkage of at least two corners (or all three) of the triangle, in contrast to those (as implied by other approaches) aiming at improving performance in one of the corners, with only implicitly referring to potential spill-over effects on the other two.

By the logic of the KT as interaction between the spheres education, research and innovation, each policy that solely addresses one of these spheres has an effect on the other corners of the KT. But the term 'KT policies' should only be applied to those policies, measures and instruments, that explicitly address the integration of all the three angles of the triangle e.g. Finland's Open Innovation Platforms or types of Centres of Excellence/Competence Centres (e.g. Austria's COMET, Swedish' VINN Excellence Centres).

The KT addresses several layers of policy making, from local and municipal to regional and national as well as multinational authorities. The question which vision prevails in the strategic interpretation of the KT therefore is dependent on the orientation of a national/regional innovation system and on the country's' STI governance system.

What could be synthesised from the several examples that were brought forward in this chapter is that the implementation of institutional change at higher education institutions and other actors requires appropriate incentive mechanisms, whether this might be competitive public programmes, national or regional strategies underpinned with dedicated budgets, specific measures embedded into public block-grant allocation mechanisms etc. As pointed out especially in the evaluation pilot of Sweden's attempts to anchor the "third mission" at HEIs, already small amounts of funds could have significant mobilisation effects, especially when they manage to leverage private funds. The concept of the KT hence supports policy makers by providing a deeper understanding that investments in one side of the KT tend to positively affect not only the other two sides but also create external impulses, from upgrading the labour market and fostering structural economic change to inspiring society, at large – often with a strong, place-based context. Thus the KT is first and foremost a practical policy frame, rather than an analytical concept. Hence, its success can and should be measured by the perceived usefulness for policy makers.

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# CHAPTER 3: PLACE-BASED POLICIES AND THE KNOWLEDGE TRIANGLE

## 3.1 Introduction

Despite an increased global embeddedness of research institutions encouraged by developments in digitalisation and transnational research cooperation, geographical proximity continues to be an important determinant for the engagement of HEIs in knowledge transfer activities. Several studies shed light on HEIs role for regional development (e.g. OECD (2007); Veugelers and del Rey (2014); Goddard and Puuka (2008), Unger et al. (2016)) allowing for a broad classification of transfer channels. Many of the already generally described and discussed channels of knowledge transfer (see chapter 2) are especially in a regional context because these activities determined by the structure of the respective regional ecosystems such as the existence of firms, funding sources and networks and vice versa are decisive locational factors for companies and hence for a region's economic performance and competitiveness. It has to be noted that most of these interactions takes place in the "functional regional" area (Box 3.1).

**Box 3.1. The functional region for innovation**

The relevant functional region for innovation will depend on both analysis of the general conditions of the cross-border area as well as innovation-specific assets and current or potential linkages. The relevant area may not map neatly to administrative borders on either side of the border, so some trade-offs may be required in deciding on the general area for intervention. Innovation partnerships do not stop at administrative borders, and can benefit from proximity.

Innovation is an interactive process, involving collaboration and partnerships amongst firms, between firms and other actors such as educational and research organisations, and with user communities. This interaction takes place both at a distance, and in proximity. The importance of this closeness for face-to-face interaction to support innovation is well-documented in academic studies of clusters, agglomeration economies and knowledge spillovers. Valuable partners may be located nearby, but simply on the other side of an administrative border.

*Source*: OECD (2013), OECD Reviews of Regional Innovation, Regions and Innovation, Collaborating across borders, OECD Publishing.

Typical instruments of formalising and organizing knowledge transfer activities are by their nature tied to their region of location and the cooperation of geographically close actors, such as clusters, science parks or incubators. But beside these channels, a key function of HEIs still is the contribution highly qualified graduates for the regional labour market as important factors for region's attractiveness as company location. Companies quite often express their educational needs to HEIs or even engage in the development of curricula or collaborative educations (e.g. dedicated professorships or courses).

Furthermore, besides contributing to the competitiveness of regions in the global competition about companies' location, HEIs are decisive factors that shape the societal, demographic and cultural structures of a region. This includes the attraction of young skilled people and the resulting positive spillovers from regional infrastructures such as education institutions or the supply with cultural activities.

Additionally, HEIs provide a direct economic stimulus for regions through several channels; i) as an employer and resulting benefits for regional demand; ii) through the demand created by its students; iii) through the expenditures and investments in infrastructures [e.g. Musil and Eder (2013)]; iv) by

contributing to the "knowledge branding" of a region that may positively affect not only reputation but might also has touristic effects.

Vice versa, HEIs are affected by their surrounding environment through various factors other than the formal engagement in transfer activities. The institutional, geographical or ecological environment (e.g. architecture, natural resources, landscape, fauna and flora) may be the starting point the development of specialisations in scientific and educational fields serving as unique selling propositions since these factors are not transferable. An example is the research focus on the "Alpine Region" of the University of Innsbruck in Austria.

The perception of regional ecosystems as key factors for not only HEIs' activities but also the performance of the national innovation systems follows an OECD-wide trend towards the shift regional development policy paradigms. Traditional cohesion policies, focusing on transfers to lagging-behind regions, have been increasingly replaced in the past two decades by an integrated approach emphasising regional innovation ecosystems. Universities and higher education institutions have a vital role in these innovation ecosystems, first, because they are central providers of knowledge and skills, second because they can support policy makers in the design, implementation and evaluation of strategic concepts and measures.

To illustrate, the policy concept of *Smart Specialisation* explicitly addresses the co-ordination along the regional KT of actors as key paradigm for the design of regional structures to support the integration of several spheres of the KT as driving factor for sustainable, knowledge and innovation driven regional development (e.g. EC 2012, OECD 2014). In many countries regions or sub-regional administrative entities such as cities and municipalities participate in STI policy matters to a different degree. Activities may range from the kick-off of strategic planning processes, the provision of funds for innovation related activities such as clusters, towards formal responsibilities with regards to the governance of HEIs e.g. in Germany or Spain. Depending on the constitutional role of regions in STI policy making also the degree of formalisation regarding the implementation of co-ordination mechanisms varies. In Denmark for example, regional Growth Fora serve as legally embedded coordination instrument between scientific, economic and political actors in region. In the Netherlands so-called "triple-helix" structures have a long tradition in the bottom coordination of regional actors, often organised as a commonly financed councils or associations, have a long tradition in the organization of shared activities, not necessarily in accordance with administrative regional boundaries. The Swedish' VINNVÄXT program (Box 3.2) serves as an example for a public funding scheme that emphasizes a holistic perspective in the integration of actors as well as a bottom-up approach in the identification of areas for action, contributing to knowledge-based regional development.

**Box 3.2. The Swedish VINNVÄXT Program**

The Swedish VINNVÄXT Program, implemented by the Swedish' innovation agency VINNOVA in 2001, serves as an example for integrating the concept of the KT – though once again not explicitly - into the strategic agenda setting of regions. Its aim is to promote the implementation of internationally competitive, research and innovation-based milieus along strategic growth areas, based on the existing potential of a region in terms of available skills, institutions, enterprises, special geographic features and resources. It provides funding for the development of institutional infrastructures for cooperation, involving all relevant stakeholders in a region with the prospect of a long-term overhaul of the regional innovation system rather than individual projects, buildings or initiatives. This requires coordinated measures and investments from private, public and institutional funds as well as long-term political and institutional commitment. The geographical proximity of actors and the development of a "common language" in terms of potentials and requirements of a region form the cornerstones of the programme.

VINNOVA funds activities of regional consortia up to EUR 1.1 million (SEK 10 million) annually for a period of up to 10. Support measures address two types of activity: firstly, strategic processes for mapping potentials and strategy development to further develop the regional innovation system, such as process management, scenario analyses (up to 20 years into the future), and the resulting formulation of strategies. The second form of support provided by VINNOVA under VINNVÄXT covers the promotion of cooperative R&D and innovation projects between universities and research facilities. Projects are selected by way of competitive tenders, involving an international expert jury. The development of the projects is monitored on an ongoing basis and a progress report must be submitted every three years. In the first phase of funding, the focus will be on strategy development activities, followed by the implementation of concrete projects. Measures includes, e.g. the support of new spin-off companies from research institutes or companies, the provision of risk capital, the promotion of technological competence sharing and networking between institutions, joint marketing activities, the recruitment of high-level skills and the provision of housing and work infrastructures. Many VINNVÄXT funded consortia and projects also put emphasis on the inter-sectoral mobility of students (e.g. internships in companies, joint projects) and the development of regional specific education programmes.

Since its implementation in 2001, 18 consortia have been selected for funding in three competitive calls, the latest in 2016. The programme is subject of frequent evaluations, both on the level of outcomes of individual projects and consortia as well as regarding is structural features and implementation processes, that result in adjustments. The latest took place in 2013 with the integration of Open Innovation as core paradigm for funded innovation activities (in opposition to a 'technology push' approach) and the explicit reference to Smart Specialisation as guiding principle for regional development. Furthermore, green growth and sustainability as well as the societal impacts of the programme should be emphasized.

*Source*: VINNOVA (2014); Lindqvist et al. (2013).

Incentivising HEIs to put specific emphasis on the engagement with their region of location is a complex task. Challenges for implementing and assessing policies in this vein arise especially regarding i) the different roles of HEIs according to their teaching and education missions, ii) differences in the institutional landscape of regions, iii) differences in governance and funding responsibilities between the national and regional level regarding HEIs, innovation policies or regional development that may lead to contradictions in incentives. Hence, the degree to which regional structures and innovation policy planning and implementation can address the whole KT varies greatly. Vice versa, taking a national perspective on the KT, e.g.in HEI funding and policy making, the role and potential of regional eco-systems have to be anticipated.

While these structural differences create difficulties in assessing and benchmarking regional engagement of HEIs other difficulties stem from tensions between HEIs regional engagement and the push for global competitiveness regarding scientific output or the attraction of talents. Even though e.g. performance agreements in some countries already explicitly refer to regional engagement as key task of HEIs, there are trade-offs between the place-based dimension and other policy targets such as scientific excellence, commercialisation or educational efficiency, and are only poorly reflected in monitoring schemes and performance indicators.

***Higher education institutions and their local interactions***

Higher education institutions are central actors in the strengthening of the linkages among education, research and innovation at different geographical scales, including at the local and regional level. Universities contribute to regional development in many ways (Table 2.1) principally by:

- Providing education to students and adults willing to engage in life-long learning activities, to contribute to upgrading and reskilling of the local labour pool;
- Engaging in research activities at the basis of new ideas generating local knowledge spillovers;
- Transferring knowledge and establishing collaborations with public and private actors in the region, potentially generating innovations (Veugelers, Del Rey 2014).

In addition, universities are large employers, attracting considerable number of students, business visitors, and project funding to regions. In the case of some of the world oldest or most prestigious universities, there is a clear contribution to regional branding and the city or region's image and identity, as in the case of Bologna, Heidelberg, Leuven, Oxford and Cambridge (Veugelers, Del Rey 2014). Universities can be the vehicle for acquiring entrepreneurial skills with possible direct impacts on the creation of new firms in a given region.

National and regional governments are trying to engage higher education institutions by placing a stronger emphasis on the educational contributions of HEIs and not just their research outputs. This includes for example the issue of encouraging both the teaching of entrepreneurship at universities but also the creation of spaces where entrepreneurship can flourish on campus (*e.g.* Alto University's campus factories or the Invention Centre at Georgia Tech where students can develop technologies that can then be commercialised). In Germany, for instance, universities have recently increased their regional activities. Larger universities, in particular, do not perceive this as contradictory.

**Table 3.1. HEIs' contribution to regional development**

| | |
|---|---|
| **Teaching activities** | Training human capital for the regional labour market<br>Work experience and internships for students<br>Hiring of external professors and researchers |
| **R&D and knowledge transfer activities** | Research projects that involve local partners<br>Contractual research and business advisory services<br>Research on regional and local communities<br>Spin-offs and creation of new start-ups<br>Mobility of students and professors |
| **Facilitating external access to university facilities** | External use of laboratories<br>External use of equipment for testing<br>External use of specialist equipment for the analysis of samples<br>Use of university premises and venues for external events<br>Graduate events and employment fairs |
| **Regional engagement and regional leadership** | Public lectures or seminars<br>Lifelong learning activities<br>Contribution to public debates<br>Contributing to territorial branding, via student recruitment, research links, alumni linkages, conference activity<br>Developing a vibrant cultural environment contributing to attract and retain creative and highly skilled people. |

*Source*: Adapted from Goddard J. and J. Puukka (2008), Kroll, Dornbusch and Schnabl (2015), Benneworth *et al. (*2009).

Depending on the regional environment, the contribution of HEIs to regional development may include more or less of the features enumerated in Table 3.1. HEIs are more likely to engage in R&D, knowledge transfer activities and public-private collaborative projects in those areas where companies R&D labs or innovative firms are located. In regions with less advanced local innovation system, HEIs are more likely to contribute to local development by training human capital and contribute to regional branding or by developing strengths in research areas particularly relevant for the regions (Box 3.3). Less densely populated, predominantly rural regions often (but not always) belong to this second type of regions, whereas HEIs located in densely populated and urbanised contexts are more likely to be surrounded by companies ready to establish R&D collaborations. For this reason, some countries have developed programmes that differentiate across different types of university missions, as in the case of the Campus of International Excellence Programme in Spain (Box 3.4).

In other cases, the development of regional universities has been centred from the very beginning on the linkages with the local community, including both local government institutions and local firms, and it has been a key driver for the definition of research and education programmes designed with the aim to benefit local knowledge triangle interactions. Typically these universities also offer study programmes to develop students' entrepreneurship skills that tend to benefit the local innovation eco-system. This has been the case of Malmo University in Sweden. A core activity of this university is to develop research and education programmes with clear linkages to the societal challenges of the region. Malmo University regularly develop projects with NGOs and the involvement in collaborative activities with non-academic actors is one of the criteria taken into account to recruit academic staff. This has nevertheless created some challenges with respect to the strategic directions for the University: on the one hand the University may need to expand its (traditionally defined) research activities which are currently relatively weak; on the

other hand, the University may want to strengthen the interaction with the local community to let interactive activities grow and develop further. In Canada, the University of Waterloo (Box 3.5) promotes entrepreneurial approaches in many ways, including generous IPRs arrangements.

**Box 3.3. HEIs or PROs in peripheral rural areas: examples from Norway and Chile**

**UiT The Arctic University of Norway**

UiT The Arctic University of Norway is a public university located in Northern Norway. It was originally established in 1968 as the University of Tromso, with the mandate to provide education and a qualified workforce in the Northern region of Norway, which is characterised by a relatively scarce population and industry predominantly active in the natural resources.

In 2009, the University of Tromso was merged with the University College Tromso and was renamed UiT The Arctic University of Norway. Afterwards, UiT incorporated other three university colleges in the region, thus becoming a multi-campus university located in all three Northern counties of Nordland, Troms and Finnmark. UiT's activities are strongly influence by the local Nordic environment of the university. Key research areas include the polar environment, climate research, indigenous communities, telemedicine, space physics, fishery science and marine bio-sciences and technologies. The university is the largest higher education institution in the region, it has had since its establishment strong ties with the public sector and has contributed to the development of new public health and welfare services. Collaboration with the business sector is less developed as the region is characterised by small companies that little engage in R&D activities.

UiT is managed by a board and has an elected rector. In addition to the rector, two pro-rectors are appointed: one for education and research and one for regional development.

**Regional Research Center Kampenaike**

To promote economic development in peripheral rural areas outside the metropolitan areas of Santiago, the Government of Chile has established since the early 2000s research centres with a strong regional focus. This is the case of the Regional Research Center Kampenaike located in Punta Arenas, the capital of the Region of Magallanes located in the Southern Chilean Patagonia. The centre focuses its activities on knowledge and technology transfer and demonstrative research with a special emphasis on sheep farming. The research of the centre aims to create, adapt and transfer production processes and technology to solve specific problems of the sheep farming industry in the Region of Magallanes, with special attention to the sustainability and respect of natural resources and the environment.

The Research Center Kampenaike aims to become the most important centre on sheep farming in Patagonia by training human capital and engaging in collaboration with the business sector. The mission and the research projects on the centre are discussed with its External Board of Directors, that includes members from both the public and business sector and it is overviewed by the Chilean Ministry of Regional Agriculture.

*Source:* OECD 2015 Assessment of Research Centres in Chile, Norway Case Study.

**Box 3.4. The Spanish Campus of International Excellence Program (CEI)**

The Campus of International Excellence Program (CEI) is managed by the Spanish Ministry for Education, Culture and Sport in collaboration with the Ministry for Economy and Competitiveness, and the support of Spanish Autonomous Communities. CEI has the goal to promote strategic aggregations among universities and other research institutions and the business sector in a single Campus, to develop university-centred knowledge clusters, acting as local hubs of international excellence and contributing to regional economic development and social cohesion.

The CEI Program has identified different types of campus:

- Urban campus like those in Madrid, Barcelona and Valencia where many different universities and research centers are located in the same cities;
- Regional campus like those in regions with only one university (such as Asturias or Cantabria). In these regions universities have become a leading actor in regional research and innovation policy and in the development of smart specialisation strategies;
- Territorial campuses with connections with a specific territory like in the southern part of Catalonia,
- Sectorial campuses with a specific focus on some research and innovation areas, like in the case of the CeiA3 campus in Andalusia involving 5 universities with strengths in the agro-food sector. CeiA3 has also developed partnerships agreement with Andalusian Rural Development Groups in the field of agro-food.

*Source:* Case Study Spain.

**Box 3.5. The University of Waterloo, Canada**

The University of Waterloo's strong relationship with the information communication and technology sector is a result of its culture, its policies and the priorities of its administration. The University's 2013 Strategic Plan - *A Distinguished Past - A Distinctive Future* sets the University's direction for five years to remain as one of Canada's leading entrepreneurial universities. It intends on achieving this goal by continuing to support collaboration with the private sector through its co-operative education programme and research programme as well as supporting an innovative and entrepreneurial culture.

The University of Waterloo has established a unique creator-owned intellectual property policy that is not typical amongst universities. This policy allows students, faculty and staff to have ownership of any intellectual property they produce. If they commercialize a product, services and processes resulting from their research, they are the beneficiaries, not the University.

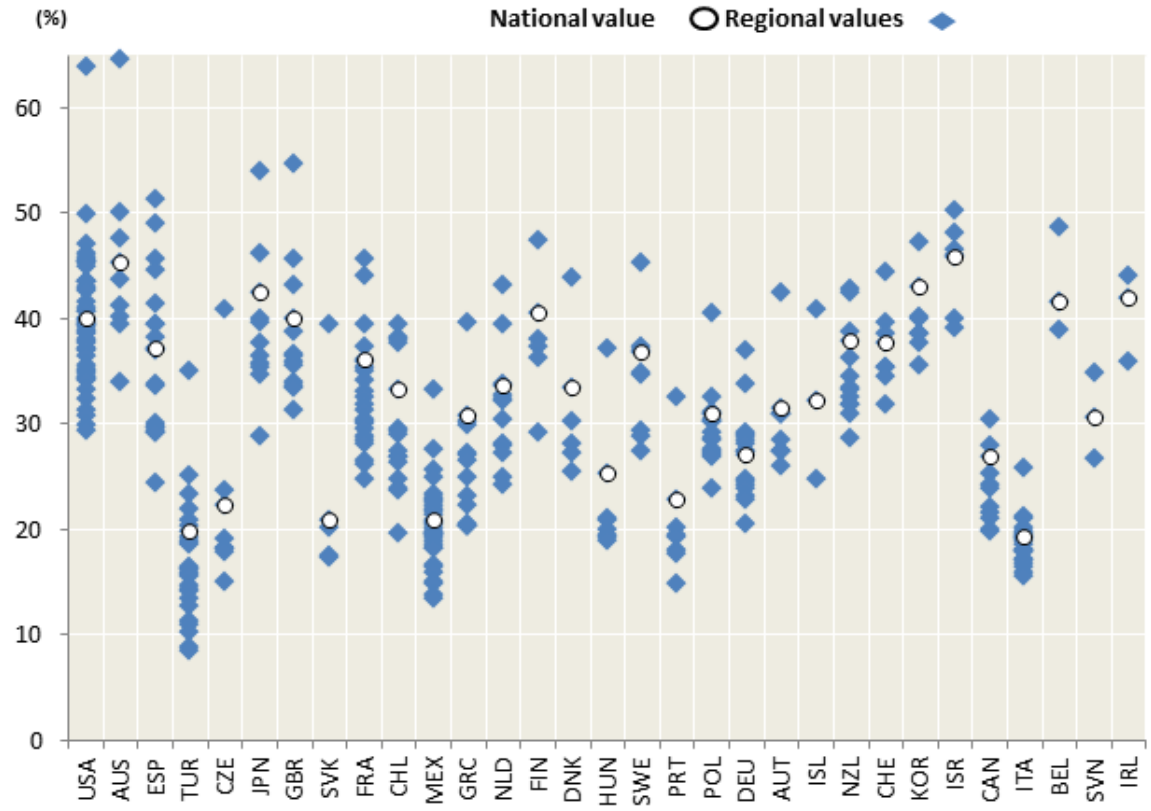
The University, since its creation, has developed closed ties with the private sector by establishing co-operative education programmes with the private sector. Co-operative education programmes also provide a mechanism that supports the exchange of knowledge between the private sector and academia. Participating organizations benefit by having access to highly skilled labour and the opportunity to learn about R&D being completed at the University, and how the University's R&D could potentially be applied to their organization. Similarly, when a co-operative education student returns to their academic studies, they bring back an understanding of what is of interest to industry. Professors and faculty hear discussions amongst students and during their courses. In many cases, professors and faculty apply the experience of co-operative education students to their courses and research.

*Source*: Case Study, Canada.

### *The concentration of innovation and skills*

Analysis of the geographic distribution of innovation and skills across countries reveals that both are concentrated in a few core regions (Figure 3.1). This may reflect long term historical economic and technological specialisation patterns. This concentration of skills and innovation expresses itself regardless of the level of development or of the overall innovative performance of national economies. Given the high concentration of innovation activity across and within countries and the diversity of local innovation environments, it is not surprising that policy makers are increasingly devoting attention to place-based approaches, trying to promote innovation-led economic growth as a way to contribute to local economic development and well-being. These approaches often aim to strengthen the linkages between research, education and innovation at the local level that is what in this paper is called the knowledge triangle at the local level.

**Figure 3.1. Regional range of labour force with tertiary educational attainment in TL2 regions, 2014**




*Source*: OECD (2016) OECD Regions at a Glance 2016, OECD Publishing, Paris, http://dx.doi.org/10.1787/reg_glance-2016-en.

## 3.2 How to make the knowledge triangle work in a local context?

### *Responsibility for higher education, research and innovation at regional level is dependent on the institutional setting of countries, but the situation is evolving*

Depending on the institutional setting of countries, the degree of responsibility of sub-national authorities with respect to higher education, science, innovation policy varies considerably. In Germany for example, federal states may grant higher education institutions the right to award doctorates. In Spain, autonomous communities are responsible for funding public universities and regional agencies together

with ANECA (the National Agency for Quality Assessment and Accreditation of Spain) monitor the quality of higher education. Regional authorities are also involved in the authorisation and certification of tertiary level curricula.

In countries where STI responsibilities are more centralised, regional policies for higher education, research and innovation are less developed. However, even in those countries, there has been a tendency, to devolve responsibility for research and innovation at the local level. In Norway, for example, county authorities have had since 2007 an explicit responsibility for defining, funding and implementing regional research and innovation policies. One of the goals of the 2014 reform of the higher education system in Norway was to strengthen the role of HEIs in regional development. In Finland, universities of applied sciences are organisations owned by the municipalities of the region. This makes universities of applied sciences in Finland directly involved in regional development strategies.

In Austria, the Federal Ministry of Science, Research and Economy has recently launched the "Lead Institutions Initiative" to promote place-based innovation dynamics as a way to strengthen linkages between education, research and innovation. The goal of this initiative is to support priority setting within universities and to push universities to engage more in "third mission activities". The Initiative covers three periods of performance agreements between the State and universities, starting from the 2013-15 period. During this process, universities were asked to develop a local development strategy to be integrated into the broader university strategic goals.

### *Co-ordination platforms bringing together regional innovation system actors are emerging in many OECD countries*

To strengthen linkages between research, education and innovation, many regions in OECD countries have promoted the establishment of regional platforms with the aim to discuss regional development and innovation strategies. These platforms bring together key regional innovation system actors and stakeholders, including higher education institutions representatives. The reason for including HEIs in these is two-fold: on the one hand such co-ordination mechanisms can steer some of the university activity towards regional needs and on the other universities can support the definition of regional development strategies and action plans. Such platforms have, for instance, recently established in the Netherlands, Ireland and Denmark (Box 3.6) and in Greece, where a 2014 law established Regional RDI councils in each of the 13 regions.

**Box 3.6. Co-ordination mechanisms for the knowledge triangle in the Netherlands, Denmark and Ireland**

The **Danish regional growth fora (RGF),** institutions created by the 2007 sub-national reforms, have evolved to adopt a pro-active style of policy making to support innovation and growth. There are six RGF in Denmark (one for each region and two for the Capital Region and the Island of Bornholm). The public-private boards are composed of 20 members, appointed by the regional council for a 4-year period, as determined by law. The RGF include regional and municipal elected officials, business persons, representatives of the higher education and research community, and trade unions. The main roles of the RGFs are to develop and monitor regional economic development strategies as well as to recommend projects to fulfil those goals. They may recommend projects to both the regional council as well as national authorities. According to law, the RGF may cover six areas: *i)* innovation, knowledge-sharing and knowledge creation; *ii)* use of new technology; *iii)* creation and development of new firms; *iv)* development of human resources, including regional competencies; *v)* growth and development of the tourism sector; and *vi)* development activities in peripheral areas.

Since 2005 several Dutch regions, including Amsterdam, Utrecht, Brainport or Twente, have established an economic board for stimulating innovation. These regional organisations are not funded by national government, but national government strongly co-operates with these boards in regions where they exist. These economic boards include all regional innovation actors: knowledge institutions, business sector organisations and representatives from local government. In some cases, the regional economic boards select priority areas. For example, the Amsterdam economic board decided to prioritise the following 8 areas for the economic development of the region: ICT/e-Science,

Creative Industry, Financial and Business Services, Logistics, Flowers and Food, Tourism and Conferences, High Tech Materials.

In Ireland, the Department of Education and Skills is leading a project to create a network of regional skills fora. The key objectives of this initiative are to provide a cohesive education-led structure within which employers and the education and training system can work together to address the skills needs of their regions; to help employers better understand and access the full range of services available from the education and training system; and to enhance links between education and training providers so as to facilitate the planning and delivery of programmemes, which is expected to reduce duplication and to inform national funding decisions. The new regional skills fora are expected to contribute to better outcomes for learners, and to support enterprise development and job creation by providing more robust labour market information and analysis of employer needs, better alignment of education and training provision with the skills needs of each region, greater collaboration and utilisation of resources across the education and training system, enhanced progression routes for learners between further education and tertiary education and in between institutes of technology and universities. Steering groups are already in place in the South West, South East, Mid West, West, North West and North East regions of the country, and will shortly be in place in the Midlands and the Mid East. All the Steering Groups are agreed that the regional skills fora must involve all key local stakeholders in a partnership approach.

*Source*: OECD Review of Regional Innovation Central and Southern Denmark, Netherland Case Study for the Knowledge Triangle OECD project, Ireland Case Study for the Knowledge Triangle OECD project.

Other types of co-ordination mechanisms have been developed to strengthen the co-ordination of HEIs within the same region. In Austrian regions, Regional Higher Education Conferences emerged as bottom-up co-ordination mechanisms among higher education institutions within the same region. Activities that have been discussed in these Conferences include: co-operation on joint research activities, the development of regional knowledge hubs, the promotion of clusters or incubation programmes, co-operation in teaching programmes. In addition, such Conferences have become the place where HEIs in a region jointly discuss their role in the development of regional innovation strategies. To date so far, such collaboration mechanisms have been developed in Salzburg, Styria (Box 3.7), Tyrol, Carinthia and Burgenland.

**Box 3.7. The Regional University Conference of Styria, Austria**

The Styrian higher education conference, formed in 2012, includes the University of Graz, the University of Technology Graz, the University of Music and Performing Arts Graz, the Montanuniversität Leoben, the Medical University Graz as well as two university colleges for teacher education and two universities of applied sciences. Together, these nine institutions form the so-called “Science Space Styria”. With the exception of Vienna, it represents the largest cluster of higher education institutions in Austria and comprises approximately 55 000 students, a total of 12 000 employees (second largest employer in Styria), and has an annual total budget of approximately EUR 700 million. The Science Space Styria has the following objectives:

- The creation of a Styrian higher education area;
- The development of a common position with respect to regional strategic issues;
- Common vision with respect to policy, economy and society;
- Common action of awareness raising targeting students;
- Coordination around projects in higher education and research.

*Source*: Case Study from Austria.

***Embedding universities in regional innovation strategies, including smart specialisation strategies***

As key actors in regional innovation systems, HEIs may play a crucial role in the development of regional innovation strategies, including smart specialisation strategies, a concept initially developed by experts and policy makers in Europe to promote regional development based on the strengthening of local assets through innovation (Foray and Van Ark 2007, McCann and Ortega-Argilés 2011, European Commission 2014) and that subsequently gained attention across the OECD (OECD 2013*c*). The smart specialisation policy framework acknowledges that regional research and innovation strategies need to differ according to the local context (Kroll 2015) in order to promote structural change in a region. At European level, regions are encouraged to define smart specialisation strategies by selecting regional priorities and adopting a multi-stakeholder approach both in the development and the implementation of the strategy.

According to a recent survey of smart specialisation strategies in European regions (European Commission 2016, forthcoming), the involvement of universities in the development of the strategy has been very high (almost 80%). Universities appear to be more involved in the development of regional smart specialisation strategies than in national strategies. The share is higher for more advanced regions. However, universities may play very different roles in the design and implementation of smart specialisation strategies, depending on the level of innovation-intensity in a region. In less developed regions universities have had the tendency to drive the smart specialisation strategy process as they can be very powerful actors in the regional context: they can be among the few actors with the capacity to develop a strategy for research and innovation at the local level. In addition the limited absorptive capacity of local stakeholders - due to low levels of innovation in local firms and limited capacities in local government institutions makes it difficult for universities to collaborate with local firms. In more advanced regions, where innovation intensive firms and public research organisations (PROs) are present, the situation is more balanced and universities contribute together with other stakeholders to smart specialisation processes. In these regions, the contribution of universities to the local economy goes beyond the training of students and as it easier for them to establish collaboration activities with the business sector.

## 3.3 Beyond the triangle: open science and open innovation

Higher education institutions at the local level can play a role in facilitating the participation of citizens in science and innovation activities, as interactions are facilitated by proximity. In addition, local communities may feel more engaged into finding solutions to practical problems affecting specific places, such as the city or the region they live in. These new ways to collaborate raise the question of how to design policies to promote a wider engagement beyond the traditional university-industry-government actors. Some recent attempts for greater engagement include the 6cities programmes in Finland (Box 3.8) or the establishment of "innovation teams" at the city level often with the aim to find solution to challenges in a participatory way (Box 3.9).

**Box 3.8. 6cities strategy: open innovation and citizens engagement in Finland**

The 6City Strategy (2014-20) is a programme implemented by the six largest cities in Finland: Helsinki, Espoo, Vantaa, Tampere, Turku and Oulu. The programme develops strategies for sustainable urban development with the aim to create knowledge, business and jobs. The strategies are also strongly focuses on service innovations and the promotion of a competitive business employment eco-system.

The programme aims to involve the six largest cities as innovation development and experimentation environments in the spirit of open innovation. The functional city community is seen as an entity consisting of citizens, companies, research and development organisations and government authorities. The open operating model is based on the creation and testing of innovations and it aims to develop innovative procurement practices. These strategies are of national relevance as the six cities account for one third of the total population of Finland and the vast majority of the economic activities and jobs in the country.

Three main activities are part of the strategies:

- The *open innovation platforms* are used to create and test new services and products in the market;
- The *open data* at the city level (e.*g*. traffic, buildings) are shared for developing a new services and operations as well as business;
- The *open participation* aims to invite the entire city community to design and communally develop service innovations and customer processes.

The approach to innovation is strongly embedded into urban and socio-economic development strategies and includes the development of innovative procurement practices and provision of more efficient service structures within the cities. In addition, all cities work together on three-year projects that provide the basis for innovation activities and create the models for the cooperation to enable the city work as a community. Additional pilot and trial projects may be launched annually with separate funding to support, test and further develop the contents of the three main activities. Tekes, the Finnish innovation agency, has created a programme for companies to participate in the 6cities initiative. As a consequence 6cities is a joint effort of national agencies, six major cities and local actors.

*Source:* Finland Case Study and www.sixcities.fi.

**Box 3.9. Innovation teams at the city level**

The **Mayor's Office of New Urban Mechanics in Boston** has been developed to help find solutions for government challenges. It consists of a small team based in Boston's city hall which interacts with city innovators and civic entrepreneurs attempting to find solutions to some government challenge. The Office has developed a mobile app called Citizen Connect that is used by Boston residents to report problems affecting the city such as graffiti or urban infrastructure issues. Around 300 cases are reported each week. Similar apps have been replicated by other cities in the US.

The **Seoul Innovation Bureau** was established to encourage citizens and non-profit associations to find new ideas for the city. The unit uses social media tools to strengthen citizens' engagement and help identify solutions. The unit together with inputs from citizens has developed innovations adopted by the city public transport services which have then been adopted by other countries around the world.

**PS21** is an innovation team in Singapore established by the head of the Singaporean Civil Service with the aim to prepare Singapore for the public services (PS) of the 21st century. PS21 engage specifically with civil servants in Singapore: through a specifically developed mobile app, Singapore's civil servants report an issue or suggest an idea for service improvement. An evaluation of PS21 estimated that over one year it generated more than half a million suggestions from civil servants of which approximately 60% were implemented, leading to savings of more than USD 70 million.

*Source:* NESTA (2014), Innovation Teams and Labs, A practice guide, London.

## Concluding discussion

Higher education institutions, together with public research organisations, are central actors in the regional innovation systems: they underpin the development and diffusion of education, research and innovation activities at the local and regional level. However, even when regional innovation policies have targeted higher education institutions, the focus has been on engaging their contribution to science-based innovation, just one side of the knowledge triangle (EC, 2011). The analysis of the recent trends to promote knowledge triangle dynamics at the local level highlights the following policy messages:

- HEIs primarily participate in knowledge triangle initiatives at the regional and local level by interacting with other key actors such as regional development agencies, the business sector, and

citizens who are increasingly involved in education as well as open science and open innovation. Private non-profit actors are also important components of local knowledge triangle interactions in some regions.

- HEIs have very diversified roles and missions depending on the local context and their position in global science and innovation networks. Not all HEIs may excel in all these different tasks and trade-offs may arise: for example some research teams devote more efforts to the establishment of international research partnerships whereas others contribute a significant part of their activities to serve the needs of local actors.

- New governance mechanisms are emerging to embed HEIs in the local context. This can take different forms: from *ad hoc* governance bodies to co-ordinate HEIs at regional level among themselves and with regional governmental agencies and the business sector, to explicit regional innovation strategies. This second form is emerging in European regions due in part to the EU's smart specialisation policy towards the regional structural funds.

- Some countries are adapting and diversifying national innovation policy according to the local context (for example national policies to promote innovation in cities vs, rural areas). Given the high diversity of local knowledge triangles (urban vs. rural, level of development of the regions, level of absorptive capacity of local firms), it is important to diversify or adapt the innovation policy mix according to the local context of both the HEIs and the local innovation eco-systems.

- In innovation-intensive regions, local government and local actors are promoting initiatives going beyond the more traditional knowledge triangle approach to encourage new participatory forms of innovation, often focused on social challenges and engaging non-profits alongside start-ups and existing business firms.

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# CHAPTER 4: LESSONS FROM THE KT CASE STUDIES

## 4.1 Introduction

Higher education institutions (HEIs) and public research institutions/organisations (PRIs/PROs) are central actors in innovation systems. The Knowledge Triangle approach in policy calls for a better integration of education, research and innovation at HEIs and PROs in order to increase their contributions to the local and national economy. But the diversity of institutional models means that their contributions to innovation vary greatly within and among countries.

This chapter presents the summaries of a series of country case studies that have been prepared by countries participating in the CSTP/TIP project, using a common template, in order to explore the national policy frameworks and institutional level practices for integrating research, education and innovation activities of higher education institutions. The chapter is therefore particularly focused on the policies, or suites of policies, and institutional practices that can improve the collective contribution of research, innovation and education to economic growth and integration of higher education and public research institutions into regional and national innovation systems.

***National policies, budgetary pressures, demographics and global competition are putting pressure on higher education to differentiate themselves and strengthen their engagement with society and socio-economic impacts***

In the large majority of OECD countries, the pressure on higher education institutions to engage with society at national, local and global level is high. Furthermore, the rise of the global competition for talent and for national research funding is also putting pressure on institutions to differentiate themselves and develop their institutional profiles vis-a-vis not only national ministries but especially students, faculty and companies. In some countries like Sweden, this pressure is felt in all dimensions of the missions of the universities. Institutions are under increasing pressure to maintain and strengthen excellence in research, education and societal engagement. This leads them to find ways to combine their missions in a strong "knowledge triangle" (Benner, et. al. 2016). In other countries, such as Estonia and the Czech Republic and due to funding arrangements (i.e. a large share of competitive research funding or reliance EU Structural funds) this pressure (for excellence) is felt mainly with regard to the research function of institutions.

***Low prevalence of the "knowledge triangle" concept outside policy circles despite increased attention towards third mission and KT activities***

The analysis from the case studies suggests that while governments and higher education institutions recognise the importance of industry-science relations, the term "knowledge triangle" is not widely used *outside* policy circles. Even in Germany, to which some observers attribute the first "triple helix" institutions in the form of the Kaiser Wilhelm Institutes of the 19$^{th}$ century (Fuller, 2009), the knowledge triangle is not explicitly mentioned by the institutions surveyed in the case study. However, there are many KT related developments taking place in Germany, mostly between research and innovation (i.e. traditional "third mission" of HEIs) and between research and education (strongly reinforced in the past few years by instruments aiming at a higher quality of teaching and between innovation and education (e.g. via business participation in the accreditation process of new Bachelor and Masters study programmes) (Daimer and Rothgang, 2016). In Sweden and Norway the knowledge triangle concept is well anchored in

governmental, institutional and political discourses and also used by institutions. In other countries such as the Czech Republic, Japan or Korea the discourse regarding the third mission is more around technology transfer and industry-science relations. In Estonia, engagement by universities with society is a relatively new phenomenon given the country's socialist economic history.

***There is a diversity of HEIs, diversity of needs and a diversity of approaches to the knowledge triangle***

Another key message is that because of the diversity of HEIs (i.e. comprehensive universities, universities of applied sciences, technical universities or regionally oriented universities) in countries, regions and innovation eco-systems more broadly, it is likely there is no single model that countries should aspire to. Institutional characteristics vary between and across countries. The case studies in Norway for example show that KT-practices differ significantly between scientific fields. Health sciences have a clear mission to contribute to high-quality healthcare services and KT-practices are integrated in the specialist health care services through the national system for interaction between the public hospitals and medical faculties, and are as such top-down driven.

The perceived societal role and impacts of HEIs on innovation varies across countries due to historical, economic and cultural factors. Levels of government oversight vary significantly across countries and, as a result, institutions have very different levels of accountability and freedom to decide their own practices. While research and doctorate training are common ways in which knowledge is generated and from HEIs, and as illustrated in several of the case study, a significant share of HEIs do not undertake significant research or teach doctorate degrees. These issues are likely to differ according to scale and geographic location. Smaller institutions or those in low-R&D areas face different challenges in interacting with external research and innovation than large institutions in large cities (OECD, 2015).

In fact, governments in many OECD countries envisage different national and regional roles for different types of institution. For example in Finland, universities are considered to have a stronger national and international role, while polytechnics are assumed to focus on their regional role (OECD 2007a). In Greece and Estonia, universities of applied sciences have been assigned a regional role that is different from the more international role of comprehensive universities. This does not mean that only certain types of HEI contribute to certain missions. However there is an element of specialisation and differentiation in higher education systems that will shape the type of "knowledge triangle". This also means that some HEIs will have different needs when implementing strategies for the KT. Some may need to focus more on strengthening education in order to link with innovation for example.

Nevertheless countries- and HEIs- share many of the same challenges in integrating research, education and innovation policies and the case studies of HEI eco-systems suggest there are certain areas of policy and institutional set ups that will require attention.

The first of these concerns the influence of the governance of STI and higher education policies at national level. Governance of HEI activities is a complex and contextually based. Different structures have emerged according to historical processes and policy changes. The second concerns the role of diverse funding sources and contractual arrangements may have on HEI incentives to change or to influence their behaviour. A third area concerns the link between place-based policies and HEI's global-local engagement; and fourth element concerns the role that evaluation and impact assessment criteria play in supporting KT activities.

***Multi-level governance arrangements for the knowledge triangle***

HEIs have been the object of government-initiated reforms for the past decades. Four main policy goals have characterised reforms. First, successive reforms have granted increased autonomy and

accountability of higher education institutions across OECD countries. Second, increasing demand for access and quality in higher education and third, increasing the quality and excellence of research. A fourth goal and one that is often pursued either sequentially or independently of the other two, is the promotion of industry-science relations.

In all of the countries surveyed in the case studies, governance mechanisms such as project-based funding, university performance contracts and research assessment exercises are common tools to increase the accountability of HEIs on the one hand, and to enhance knowledge triangle activities. However, because of the autonomy granted to HEIs, the task of co-ordinating and integrating the multiple missions of universities falls on the institutions themselves.

One of the lessons from performance contracts in OECD countries is that they have helped HEIs improve strategic planning and adapt to a changing funding landscape and position themselves in a global market for research and education. But the challenge remains how to properly assess performance and to make the performance of individuals accountable to the institutional performance.

Diversity of funding, performance indicators and evaluation practices make implementing and measuring KT activities difficult. The funding sources of HEI are increasingly diverse in terms of their source (i.e. national, regional, international, business and charities) but also their nature (institutional block grants, competitive project-based, or industry contract-based). This diversity is reflected also in the indicators and metrics for monitoring the use and impact of the funds.

Evaluation results serve as a basis for the distribution of institutional funding of research organisations. While competitive funding streams often encourage the diffusion of research outputs to society, the metrics used will vary according to the project or reporting requirements of the funder. In some cases, however, KT activities are not included in the evaluation criteria. As a consequence, the indicators to evaluate HEIs are pre-determined and biased towards the goals/criteria of the funding sources.

In the case studies, several countries noted the fragmentation in governance. At national level, the co-ordination of education, research and innovation policies is important. In many countries, this co-ordination takes place through inter-ministerial councils or through strategic documents (i.e. innovation strategy documents) that set out the direction for joint policy action. But co-ordination is needed also with regional and, increasingly, municipal governments.

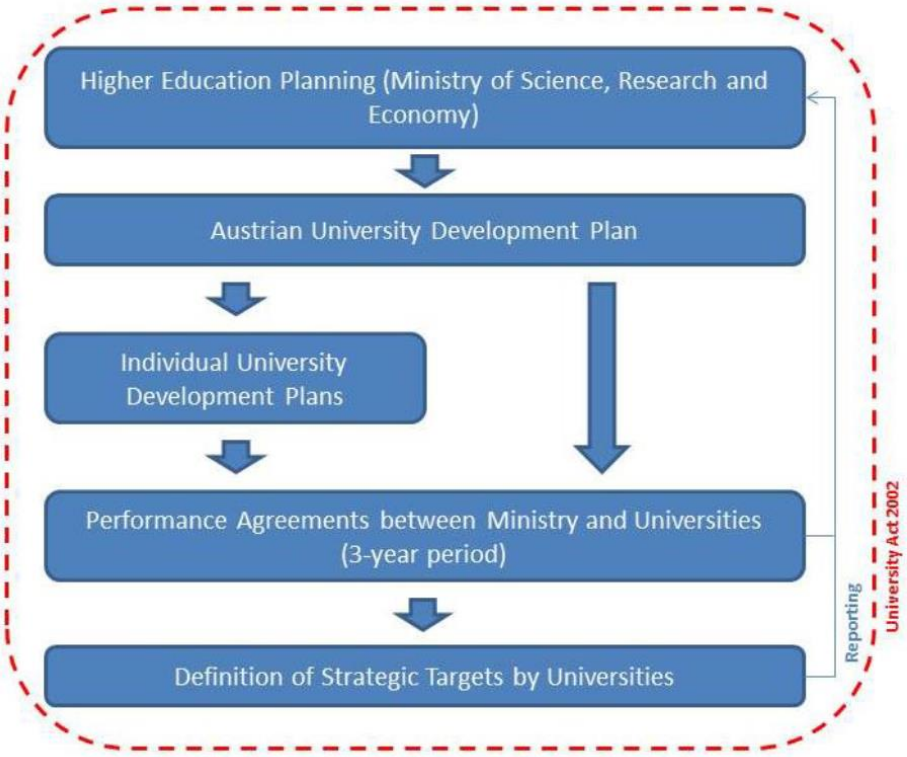
***Funding structures***

Between and within OECD countries, the funding structures vary and depend on the private and public status of higher education institutions. Generally however, education funding and research funding streams are distinct. However, the silo model of funding and regulations for the different missions, however, does not facilitate the tasks of integrating KT activities at institutions. This altogether places large expectations on universities to align the missions and create interaction between the different tasks (Benner, et al. 2015). This results in a dual and sometimes fragmented governance system. Institutional choices are determined by internal governance structures (e.g. rectors, faculties and departments) that are influenced by (supra) national, and regional policies with regard to legislation, quality assurance, and funding.

In the Austrian case for example (Figure 4.1), the main instrument to steer HEIs are the three year performance agreements. Activities towards KT are manifold and cover entrepreneurship, the alignment of curricula, the establishment of three regionally clustered and one thematic Knowledge Transfer Centres at universities and, besides, other strategic targets, the "Lead Institutions Initiative" (*Leitinstitutionen-Initiative*). The "Lead Institution Initiative" sets out the respective requirements concerning the strategic

interaction of universities and their location (region) in order to contribute to the development and implementation of regional STI strategies as knowledge based *lead institutions*. In a KT context, the Lead Institutions Initiative is a holistic effort to place HEI as acknowledged partners in shaping regional innovation ecosystems, and to shift the focus from purely institutional planning to the development of profiled knowledge places. As in other countries, competitive funding is used to steer and encourage HEIs to develop their institutional profiles and for this Austria has a range of funding instrument for strengthening partnerships between universities and business.

**Figure 4.1. Public instruments for university planning and steering: the Case of Austria**




*Source*: Austrian Knowledge Triangle Case Study (Unger, M. Wagner-Schuster, D. and Polt, W., 2016).

### *Place-based and HEI eco-systems*

In the past, neither public policy nor the higher education institutions themselves have tended to focus strategically on the contribution that they can make to the development of the regions where they are located (OECD, 2007). Indeed, in many countries, higher education and research funding policies are "spatially blind". This is now changing as policy makers recognise that geographic distribution of knowledge production and its application is a critical factor that underlies the globalisation – as well as – the localisation of economic activities, and hence the sources of growth and well-being. Another reason for this change is that innovation policies have expanded their rationales. Rather than focusing only on market failures, the modern approach to regional innovation policy has expanded towards a broader logic of correcting a whole range of "system failures" in regional innovation ecosystems. System failures include network failures, incentive structures or principal-agent problems. As universities are increasingly autonomous, independent and "entrepreneurial", they can engage with regions and cities. Programmes to support clusters and excellence hubs are frequently used, but more so at regional than national level. Furthermore, regional governments account for a notable and growing share of public spending on innovation-related matters. In Sweden the SRAs, SIAs and CDI funding modalities are all new mechanisms that aim to catalyse multi-stakeholder interactions at the regional level (OECD, 2016).

The role of HEIs in the regions also depends on the relative power of the actors; in a government-pulled model, entrepreneurial universities assist the development of existing industries and creation of new industries in response to incentives from government. In an industry-pulled model, universities respond to opportunities for co-operation with industry to co-operate on specific problems or deliver services (Lindqvist et al. 2012).

Notwithstanding the rise of interest in place-based innovation policies, in some OECD regions, co-operation between universities and external partners has a long history and has been supported by existence of industrial and scientific infrastructure in the region (e.g. science and technology parks) as well as clusters and regional support structures to foster innovation. In others, this collaboration had been promoted by (supra-) national or regional-level policies and by the availability of increased funding to foster research, innovation and knowledge transfer.

The case studies with a focus on place-based innovation highlight three important trends:

1. *New governance structures to engage regional stakeholders*. The Austrian case illustrates the role that regional university conferences can play in the joint planning of activities of HEIs at a region of location, e.g. the alignment of curricula and research profiles but also the exploitation of results and strategic co-operation with business sector. Furthermore they serve as coordinated voice of HEIs in the development and implementation of regional STI strategies by the public sector. The Netherlands case shows that while HEIs are increasingly engaging local stakeholders on university boards or for fund raising, the corollary is also important. Economic development agencies can arguably do more to engage HEIs in their public service delivery missions, urban planning or "smart city" initiatives. The case study of the HEI eco-systems in Netherlands suggests that the funding and management capabilities of regional boards has an impact the effectiveness of regional actors in steering entrepreneurial eco-systems (Stam, E., et. al., 2016)
2. *Open innovation platforms* can be a tool to combine different knowledge base and organise innovation related interactions with external partners. The platform approach used in Finland distinguishes itself from the cluster approach through its focus on people-based interactions and openness (Raunio et al. 2013).The rise of platform approach to collaboration is an extension of the digitalisation of technology and production which fosters the emergence of new modes to organise co-operation also in innovation and production activities. OIPs should foster the combination of knowledge towards innovative solutions at least in three levels: a) combination of different knowledge bases, including both science and experience-based knowledge; b) combination of codified and tacit knowledge (i.e. d*igital platform* and *physical innovation hubs* that represent the new modes of co-working and co-creation spaces and; c) combination of citizens and public services with the development process in business development and innovations refers to extension of knowledge bases to the people and the public sector of the region.
3. *Innovation Networks* are established around publically supported innovation projects that are carried out by companies, research institutes, governments and other organisations (e.g. EU Funding).

### 4.2 Institutional management and leadership

Analysis of case studies of HEI eco-systems suggests that adopting a KT approach requires modern management practices and leadership, not only at level of universities but also in the broader HEI eco-system (i.e. the vocational/technical colleges, PROs, clusters, regional development agencies). Another barrier observed in some of the case studies is that there are weak incentives for knowledge triangle practices in institutional recruitment and evaluation systems (Borlaug, Siri, B. et. al., 2016).

## 4.3 Individual action versus collective action

It is also important to consider the issues of the knowledge triangle from the perspective of individuals. One of the issues that emerged in several of the case studies was that KT activities can often be explained by the actions and incentives of individuals within those institutions. As mentioned in the case of Estonia, successful integration of research, education and innovation at HEIs are in many cases based rather on the initiative of faculties. This is also one outcome of the project-based funding system, as the availability of strategic funds on the university level is restricted.

***Third mission and broader engagement***

Third-mission activities can refer to a number of different practices, and can themselves be categorised to those referring to research (e.g. technology commercialisation and knowledge transfer), education [(e.g. lifelong learning/continuing education), and social engagement (public presentations, voluntary work by staff etc.) (EU, 2012)]. As such, "third-mission policies" encompass a range of policies from commercialisation structures to softer recognition of societal role. Commercially oriented activities, although limited in the majority of institutions, do provide an important revenue stream for some HEIs in some countries. Income from contract research, for example, has become an important source of income for a range of HEIs (OECD, 2013a). In Germany there is also an explicit commitment to the third mission on a legal basis: The Framework Act for Higher Education defined "knowledge and technology transfer" as a third task for HEIs in 1998. Some countries have dedicated innovation funding schemes to encourage 'third-mission' such as interaction with small- and medium-sized enterprises (SMEs). Indeed, a lack of dedicated funding was referred to in some case studies as a barrier to greater engagement in innovation-related activities.

Third mission policies therefore partially represent a more active state role to orientate higher education towards societal concerns and towards innovation. Some countries and institutions have made explicit commitments to the third mission. Sweden for example has long recognised the "third mission" of HEIs and the mission is officially recognised in the 1992 Higher Education Act. This sets Sweden apart from most OECD countries, where the third mission is often an implicit rather than explicit aim or expectation of government policy. However, despite the legal backing, the third mission is an unfunded mandate. In other countries, there is dedicated innovation funding to encourage knowledge exchange activities such as interaction with small- and medium-sized enterprises (SMEs). Some countries have also made efforts to measure and record collaboration and dissemination activities. Such policies can also be seen as a response to the "innovation paradox" and concerns in many countries that high-quality research has not translated into innovation performance (IPP, 2015*a*). The concept of the third mission also highlights the role of HEIs as nodes within broader innovation ecosystems and the two-way interactions between HEIs and other actors.

There are potential trade-offs between the third mission and the traditional teaching and research missions. An increased commercialisation and profit-seeking attitude associated with financial autonomy may have competing effects on an HEI's research activities. For instance, a push for commercialisation could impinge on an HEI's willingness to extend informal expertise. The institutionalisation of knowledge transfer activities at HEIs may also hinder rather other forms of knowledge flows (Guena, 2015). Faculty that could earn money from consulting activities could also have less incentives (and time) to engage in community outreach. Another concern is that there are trade-offs between teaching and other missions. Teaching and research tend to be complementary although the evidence shows nature of the relationship between the two is likely to vary by fields of science and education. Nevertheless, the long-running increase in the rewards to research relative to teaching is often argued to have weakened the relationship between the two.

These tensions where apparent in some of the case studies, notably in the case of the comprehensive universities.

### 4.4 Impact assessment and evaluation

The role and impact of universities depends on a range of external factors. For instance, the existence of public research institutions or publicly-supported "bridging" institutions can affect the impact of higher education research, or the ability of HEIs to find collaboration partners. However, treatment of HEIs in the analysis of the knowledge triangle must recognise the diversity of institutions. It is clear that HEIs cannot be treated as a 'black box' – the way they are organised, how they teach, and the relationships that staff build outside the institutions all have an impact on innovation outcomes. The criteria of stakeholders such as research funding agencies, ministries but also business influences the design and use of evaluations and impact assessments. In some cases, the criteria are not always aligned with university missions and this factor has to be taken into account when trying to ensure the results feed back into national policies and institutional strategies.

# PART II. CASE STUDY SUMMARY PROFILES

| Austria | Place-based dimension in higher education policy making |
|---|---|

**Summary:**
The Austrian case study focused on the place-based dimension at different levels of Austrian higher education policy making and the role of governance mechanisms, including performance contracts and new structures to involve universities at regional level.

***Authors**: Maximilian Unger, Daniel Wagner-Schuster, Wolfgang Polt, Joanneum Research, Austria*

**Funding**

The current funding procedure of HEIs is under revision to include capacity orientation and some competitive elements in a better way.

To promote knowledge transfer especially between academic research and the business sectors a variety of competitive instruments exists. There are different medium- and long-term programmes to support science-industry relations on the institutional level. In many cases, partners from academia and business set up common laboratories or research centres which are operated as independent legal entities. Funding of individual projects is less common in technology transfer. There are also regionally clustered accelerators in place at several locations in Austria to support academic start-ups.

**Place-based policies**

The "Lead Institution Initiative" as part of the performance agreements between the Federal Ministry for Science, Research and Economy and universities aims at the following strategic targets:

- to position universities as self-confident partners in the development of locations and regions on equal levels with other stakeholders in the knowledge triangle ('turning stakeholders into partners'),
- to increase international visibility of universities as regionally embedded knowledge hubs for scientific and business cooperation,
- to shift the strategic perspective from individual institutions towards the development of knowledge locations leveraging administrative, infrastructure and competence synergies,
- to increase the quality of cooperation and coordination in management, teaching, research and innovation activities as basis for the provision of public funds for location oriented projects (e.g. procurement and use of research infrastructure, establishment of joint core facilities, alignment of curricula according to location specific needs, joint appointments by institutions, permeability between different types of institutions at a location, management activities).

Universities are asked to develop strategic concepts and milestones according to the targets of the initiative.
This should enable universities to take their role as knowledge based lead institutions for regional development and as strategic partners in the development and formulation of regional STI strategies of the public sector along the concept of *Smart Specialisation*.
The implementation of regional higher education conferences *(regionale Hochschulkonferenzen*) in most Austrian regions ('Länder') that host universities was an important step in operationalising horizontal co-ordination between different HEIs in a region. Regional higher education conferences are designed to address the needs for co-ordination of public universities, universities of applied sciences (UAS), university colleges engaged in teacher education, and, in some regions, private universities. The university conference at the national level (UNIKO) mainly acts as a political voice for universities by allowing them to adopt a coordinated position concerning questions relating to social or higher educational matters. In contrast, regional higher education conferences act as hubs concerning the implementation of co-ordinated projects and initiatives (together with other components of the knowledge triangle), both in terms of research and education.

**Key measures to promote KT activities**:

- The Austrian Competence Centre Programme, COMET
- Christian Doppler Research Association (CDG). These programmes aim to improve industry-science linkages by promoting collaborative research and innovation projects and the development of human capital, e.g. via doctoral education and employment mobility.
- The AplusB-centres (academia plus business programme), located throughout Austria in co-operation with HEIs to provide support for the creation, acceleration and scaling up of academic spin-offs.
- The "Knowledge Transfer Centres and IPR-utilization" (Wissenstransferzentren, WTZ) was launched in 2014 to support universities' patenting activities.

**Policy lessons:**

- The "Lead Institutions Initiative" provides an example for how an enlargement of universities' spectrum of activities and missions can highlight their position within a critical network of excellence with strategic partners in industry, business and academia in self-selected area of close collaboration.
- Regional engagement through regional university conferences is essential.
- Competitive funding instruments that anticipate KT principles are typically targeted towards the development of medium- to long term structures for collaboration rather than projects. Programmes and institutions such as the COMET centres of the Christian Doppler research labs are especially important with regard to the development of human capital to work at the interface of universities and industry.

| **Canada** | **Case study on Canada and the Waterloo Region Knowledge Triangle** |
|---|---|

**Summary:**
This case study examines the relationship between the three corners of the knowledge triangle from a Higher Education Institution (HEI) perspective, specifically focusing on the university level from a national science and innovation perspective. The Canadian case study consists of five sections. The first section: Overall State of the Knowledge Triangle in Canada provides insight into the characteristics of Canada's national innovation ecosystem; the second section: HEI in Canada and the Knowledge Triangle examines the characteristic and contributions of HEIs to the three corners of the knowledge triangle and the interplay between the three corners. The third section: Institutional Level Policy provides insight into the Government of Canada's strategies to guide federal investment in science, technology and innovation in relation to the three corners of the knowledge triangle. The fourth section: Funding showcases the Government of Canada support for HEIs as well as federal programmes and initiatives under each corner of the knowledge triangle. The fifth and final section: The Waterloo Region case study: provides an example of the knowledge triangle in the Canadian context by showcasing a Canadian University (the University of Waterloo) and how its characteristics, programmes, policies encourages innovation in the Waterloo Region.

*Author: Andrew Thistle, Policy Analyst, Science and Innovation Sector, Innovation, Science and Economic Development, Government of Canada*

**Innovation eco-systems**

In Canada, the relationship between education, research and innovation at HEIs have traditionally been less integrated than that of some other countries. As a result in Canada, governments (federal, provincial and territorial) have tended to treat each corner of the knowledge triangle as distinct and individual functions. However, there is significant overlap and interplay between the three corners. Within Canada, innovation ecosystems exist at the local, regional/provincial and territorial level and at the national level. At each of these levels there are different factors (e.g., structure of the economy, political priorities and economic circumstances, etc.) which influence the interactions and relationships within an innovation ecosystem. As a result, governments at all levels have and continue to implement measures that support the three corners of the knowledge triangle which will help achieve their desired economic and science, technology and innovation objectives.

Canadian HEIs activities support all three corners of the knowledge triangle. Currently, Canada has approximately 100 universities and approximately 300 colleges (with 2/3 of them being publicly funded). Over 2 million students are enrolled in these HEIs. These HEIs play an important role in their local communities and economies by providing an educated and skilled workforce, access to research infrastructure and expertise. HEIs can also anchor clusters of innovation activities in their local communities and act as bridges between businesses, governments and other countries.

The knowledge triangle concept is not explicitly used by the federal/provincial and territorial governments. These orders of government indirectly support the knowledge triangle concept through their policy instruments supporting innovation. To support innovation, governments use a broad suite of suite of direct (e.g., grants, contributions, vouchers, loans and equity financing, etc.) and indirect (e.g., tax credits) instruments. Many of the Government of Canada's programmes and initiatives are designed with flexibility so they can be applied to and meet the needs of Canada's diverse regional economies.

The Government of Canada's direction for science, technology and innovation has also been driven by broad policy frameworks. Most recently, the new federal government committing to develop a new Innovation Agenda. On 14 June 2016, the Government of Canada announced the six key areas of action for the development of its new Innovation Agenda. They include: promoting an entrepreneurial and creative society; supporting global science excellence; building world-leading clusters and partnerships; growing companies and accelerating clean growth; competing in a digital world; and, improving ease of doing business.

**Funding and governance to promote KT activities**

In Canada, the relationship between education, research and innovation is not typically characterized through a

knowledge triangle concept. Neither the federal or provincial/territorial governments (10 provincies-3 territories) have established policies which directly refer to the knowledge triangle. Despite this, the interplay between the three corners of the knowledge triangle is addressed through policy and programmes. In Canada, provincial and territorial governments have jurisdictional responsibility for education. As a result, the federal government does not have a department of education, there is no top down higher education policy, nor is there an integrated national system for education in Canada. Furthermore, HEIs operate largely independently in terms of their curriculum and administration.

**Place-based policies**

The Government of Canada's direction for science, technology and innovation has also been driven by broad policy frameworks, with the new federal government committing to develop an Innovation Agenda. Provincial and territorial governments have also tailored their efforts to support their regional innovation ecosystem to support their priorities and economic interests. The Innovation Agenda will put focus on building world leading clusters and partnerships.

- **HEIs surveyed/interviewed: The University of Waterloo**

**Policy lessons:**

- One of the biggest challenges facing Canadian HEIs is transferring their knowledge to industry. This in fact is illustrated in Canada's lagging results for licensing activities and the creation of spinoff companies and start-ups at Canadian universities. There are several factors which influence the commercialisation of research and knowledge produced by Canadian HEIs. They include: the different cultural orientations within Canadian universities; a university's intellectual property rights policy; and, finally the structure of the Canadian economy which largely consists of small-medium-sized enterprises.
- The content and administration of intellectual property policies vary significantly across Canadian universities. Some universities have an institution-owned intellectual property policy, giving the University ownership and the rights to all inventions made by faculty, staff and students using the institution's facilities. Contrary to this, other universities have intellectual property policies that provide full ownership of intellectual property to its creator, which can make the commercialization of these ideas more attractive. Some evidence suggest that the more liberal an intellectual property policy is, the more it encourages entrepreneurial thinking by faculty and students, contributing to the creation of start-ups. Other evidence suggests that the nature of the inventions, the overall quality and resources of technology transfer offices at HEIs, and the HEIs' culture surrounding partnership with industry appears to play a large role in influencing commercialisation results. However, overall commercialisation outcomes are similar between HEIs in which the university owns the intellectual property rights and those in which the researcher owns the intellectual property rights.
- The administration of intellectual property through University Technology Transfer Offices also varies significantly across universities. Some universities manage intellectual property in house, while others use external-not-for-profit organisations. The mixture of administrative practices for managing
- The current promotional systems of universities are largely based upon publications. As a result, faculty may have limited interest in completing applied research or being involved in entrepreneurial activities. In addition, a university's intellectual property policies may cause tensions for faculty along with the reallocation of their time from basic research to applied research as well as their teaching responsibilities.
- The Waterloo Region case study provides insight into the interactions between the three corners of the knowledge triangle from a Canadian University perspective. The success of the Waterloo Region can be attributed to a number of factors, including a diversified industrial economy (which includes multi-national corporations) with strengths in various sectors; a concentration of HEIs (two universities and one college); a strong financial services sectors; a highly skilled workforce; support from federal/provincial and municipal governments; and a number of business incubators and accelerators.
- The University of Waterloo is an excellent example of an entrepreneurial university that operates within the environment of an innovative regional ecosystem and that encourages its students, faculty, professors and staff to be innovative. The University's co-operative education programme helps reinforce the informal and formal relationship amongst students, faculty, professors, alumni and the private sector. In addition, the University's alumni, representatives from industry, professors and faculty are actively engaged in the University's programmes and centres designed to commercialize the University's R&D and provide support to start-ups. Their support ranges from mentoring, access to financial networks and providing technical advice.
- The University's culture aligns with the entrepreneurship culture of the Waterloo Region. The Region promotes an environment conducive to innovation and entrepreneurship. Within the Region there are significant networks among the labour force, industry and post-secondary institutions.

intellectual property can make it challenging for an intellectual property creator to negotiate licenses, particularly when there are multiple universities involved.

- The knowledge and research produced by Canadian universities may not align with the interests and needs of industry. Since the 1980s, both federal and provincial governments have been implementing measures to encourage Canada's universities to become more "entrepreneurial" and to support R&D that addresses the needs of industry. To achieve this, governments have modified the requirements of some granting funding by requiring collaboration and matching funds from industry for some programmes.

- To foster greater innovation conversations and to encourage innovation activities the University of Waterloo established the annual Waterloo Innovation Summit. The most recent Summit occurred from 16-18 September 2015 in partnership between the University and Communitech, a leading business incubator and accelerator. The Summit brought together top academics, business and policy decisions makers where they heard from innovation influencers, shared best practices and learned how to develop an innovation culture through the continued development of technologies, approaches and industries.
- The University of Waterloo contributes to fostering innovation within the Waterloo Region through its entrepreneurial culture; its intellectual policy; and, support to entrepreneurs to commercialize their discoveries. It is a Canadian HEI leader for supporting innovation and for collaborating with the private sector. Many Canadian provincial governments and HEIs are looking at the Waterloo Region for inspiration to strengthen their innovation ecosystem. Entrepreneurship is promoted both in the University's programmes and in practice, through co-operative education programmes.

| Czech Republic | Higher Education Eco-systems and industry-science relations |
|---|---|

**Summary:**
The Czech Republic higher education sector is characterised by underdeveloped structures for KT activities; a low integration of educational, research and innovation activities and low revenues from R&D co-operation with industry. The evaluation of research and human resource polices also do not foster KT initiatives. Considering the small territory of the Czech regions, research focus of the universities as well as their co-operation with the business sector has largely trans-regional, i.e. national or international character.

***Authors:*** *Vladislav Čadil and Miroslav Kostić, Technology Centre of the Czech Republic, Prague*

**Funding**

Funding of the selected universities is strongly dependent on public resources, only a minor share of resources is generated by business activities of universities. Another feature of financing, typical for the majority of Czech HEIs during the last years, is a high share of the EU Structural Funds on revenues – reaching 33% on the total revenues of TUL and even 37% in the case of UPO in 2014. The EU Structural Funds have been recently of a great importance especially for building new research infrastructures and modernisation of existing research facilities. However, financial sustainability of the newly built large infrastructures tends to be a major R&D policy challenge in the near future.

**Place based policies and HEIs**

Neither the Czech legislation nor policies or strategies distinguish between individual types of universities. All universities are equal and are managed and funded by the same rules and from the same resources. Involvement of the business sector in relevant bodies of the universities (Scientific Board, Board of Governors) is relatively low, only in the Board of Governors of the UCT the business sector has a half share on the number of representatives.

The three universities belong to the key stakeholders at least in their regions in terms of connecting education, research and innovation. The two universities located outside Prague (UPO, TUL) represent the main research institutions in their regions and cooperate the most intensively with regional authorities on regional development issues, especially on the design of regional strategies.

**Types of co-operation at the regional level:**

- Co-operation with regional authorities on regional development issues (drafting and implementation of regional innovation strategies and plans)
- Co-operation with research organisations and businesses in the region, activities of science & technology parks
- Linking the research and educational orientation of universities to the regional economy.

**Higher education institutions surveyed**

- Traditional university – Palacký University Olomouc
- Technical university – University of Chemistry and Technology (UCT) , Prague
- Regional university – Technical University of Liberec, highly specialised university (TUL)

**Barriers to KT activities**

- HEI leadership staff is elected mostly from academia. Thus, inbreeding and weak managerial background of the top leadership is a barrier to the promotion of KT activities in the Czech higher education sector as a whole.
- During selection procedures for new researchers, co-operation with industry is only partially considered in the evaluation at the UCT.

**Policy lessons:**

- In very general terms, knowledge triangle activities are relatively little institutionalised.
- A thorough evaluation of results and impacts of such activities and initiatives seems to be a major challenge for the three HEIs and for the other Czech HEIs as well.
- On the other hand, knowledge triangle development at HEIs is in a gradual progress. It is therefore possible to notice recent acceleration of these on-going processes at the Czech HEIs, expressed e.g. in the development of institutional structures for knowledge and technology transfer.
- The trend to connect education, research and innovation in the higher education sector are influenced by different starting conditions, possibilities or aims of individual universities. Among the three different types of Czech universities in the case study, there are differences in the emphasis put on the particular angles of the triangle. Nevertheless, a balanced concentration on the three angles according to the dispositions of individual HEIs should be the aim of all universities in order to maximise their benefits for the society.

| **Estonia** | **Developing research organisations with project funding instruments** |
|---|---|

*Author: Kadri Ukrainski, University of Tartu, Estonia*

**Summary:**
KT relations in Estonia are evolving in funding environment where the share of project-based funding instruments especially in research funding is extremely high and growing in education funding. On the country level, it can be concluded that the understanding of universities as important players of KT has also reached gradually the managements and governing bodies of the universities. However, the universities are struggling in balancing the new roles with the traditional academic ones and have difficulties in enforcing the new roles in their internal policies and procedures. It has been argued that many R&D institutions of Estonia are simply not ready or not motivated to change the procedures, way of thinking and culture of organisations (Okk 2015). Also, the low, but evolving capabilities of firms and the concentration of R&D activities in small number of firms is related to the context of building KT relationships. Therefore, the KT relationships are evolving, but not at the speed that could be expected in the country of such small size as Estonia.

**Funding**
In Estonian universities, project-based competitive funding represents more than 90% of research funding in all public universities, smaller R&D institutes are often 100% project funded. One of the reasons behind is high dependence of the research system (about 60%) from EU Structural funds. Clear focuses (strengths) of the case universities in the KT relationships can be profiled.

**Industry-science relations**
As the universities are relatively small, but opening up to global competition, their capabilities and resources to create high-quality knowledge transfer mechanisms are very limited both financially and in terms of competences. Here greater co-operation is needed, which has only started between UT and TUT. Here the high dependence from project based research and innovation (but growingly also education) funding comes to play as an additional factor that is not supporting the competence building at the university level and is further inhibiting the development of KT relationships and the development of longer term capabilities according to the main specialisations of the universities.

**Institutional case studies**

- University of Tartu (UT) a large and the only comprehensive university in Estonia involving traditional variety of fields of science (including medicine), being also the oldest in Estonia (created in 1632) with location in Tartu (Southern Estonia).
- Tallinn University of Technology (TUT) is a technical university, which historically was created in 1920 as a higher education institution focusing on technical education. However, during recent decades has been focusing more on social sciences.
- Estonian University of Life Sciences (EULS), an example of regional university, which was created in 1951 by separating three agricultural faculties from the UT into a separate university. As EULS is still specialised in rural life, rural economy and in areas related to the sustainable use of natural resources, it has been selected here as the example of regional university as 68% of the students in this university originates from Southern Estonia).

**Policy lessons:**

- No systematic approach towards integrating all of the aspects of KT.
- The main activities and decisions related to the KT are decentralised to the faculties and research groups.
- In practice, KT activities are fragmented despite strategic documents that emphasize the need and aims for integrating the fields of research, education and innovation.
- The examples of successful KT integration are in many cases based rather on the initiative of faculties.
- This is also one outcome of the project-based funding system, as the availability of strategic funds on the university level is restricted.
- In the universities studies, mainly two out of three KT pillars are targeted (e.g. research–teaching, research–innovation or teaching–innovation).

| Finland | Open innovation platforms as policy tools fostering the co-creation and value creation in knowledge triangle |
|---|---|

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**Summary:**
The Finnish case study focuses on the role of open innovation policy platform (OIPs) s to illustrate the operation of the KT framework. In KT context the OIPs may be seen as a collaboration model that HEIs' may deploy when they interact with the surrounding society and economy, i.e. fulfil their "third mission. The goal of these platforms is to organise value creative innovation processes through the open innovation platforms. The main hypothesis is that the evolution from science parks and cluster (sectoral) based policies with science based and semi-closed development projects led by a few big companies are moving towards more agile and user driven processes of innovation, where open innovation and platform models are key elements of the new practice.

**Broader transition aim**
Open innovation platforms provide a new generation of co-creation spaces facilitating the interaction among the research, education and innovation thorough bottom-up process. Recently evolution extends from local activities towards regionally linked networks of open innovation platforms (Tampere region) and further to national policy agenda (National 6Cities strategy). The value proposition of OIP approach is to engage much broader knowledge base to innovation activities while offering the "city as a living lab" and user oriented open innovation services for the use of the firms and other actors (clients). Further, it organise the increasingly open public data bases and public procurement practices in order to enable both new business applications as well as development of public services in this context.

The future challenges and systemic sore-spots may be simplified to the four themes; 1) emergence of OIP networks, 2) OIPs' capability to create "network effects" and further foster the civic engagement, 3) cultivation of open innovation culture among the local firms, public organizations, and start-ups, and 4) capabilities to offer public sector's open data and public procurement processes as new sources for innovative business development and public service renewal. In the following these themes are shortly discussed. Actively investing in learning is hardly ever done. Still, both cases show signs of policy learning.

**Policy lessons:**

- The active change agent in the case of the Demola project was not the university, but the regional development agency (owned by the University of Technology) and industry who have fostered the university-industry collaboration, or even "civic engagement" in practice.
- There is clear lack of incentives for the universities to foster civic engagement, which may partly explain the situation.
- OIP approach to reach out from the HEIs towards much wider society and its renewal.
- Civic engagement goes beyond the business oriented KT approaches. This requires new indicators and performance measures for the HEIs in order to foster their activities in this co-operation with the society.
- Pressure to create collaboration models has so far emerged mostly from outside of the HEIs
- The innovation and economic activities continue to agglomerate into city-regions along with social and urban problems.
- Therefore, fostering of innovation activities through open innovation and co-creation processes that engage the wider group of users and other stakeholders to the processes, far beyond the university-industry-government collaboration in business development, is a crucial (and systemic) question.

| Germany | Knowledge triangle policies and practices in Germany |
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**Summary:**
The term "knowledge triangle" is not widely used in Germany. Third mission policies and science-industry linkages are thriving, but adoption by HEIs and PRIs is very different, depending on the institutions' structure, culture and location (regional context). In the HEIs studied the KT concept does not explicitly play a role in the strategic development of their activities. However, the activities that relate to the KT are rather important for both. The main activities and strategies of both HEIs are located in different angles of the KT. The mission of Heidelberg University has excellent research at its core. The institutional strategy of the university was successful in the national excellence initiative. Important activities are located between research and education as well as research and innovation. In the strategic fields of focus (like medicine), the university aims at integrating research and teaching and achieving a high quality of teaching. The university has close links to industry, some of which are institutionalized by long-term activities and programmes (like industry-on-campus-programmes, a federally funded research campus and two federally funded Leading-Edge clusters).

**Authors:** *Stephanie Daimer, Fraunhofer ISI, Michael Rothgang and Jochen Dehio, Rheinisch-Westfälisches Institut für Wirtschaftsforschung, Germany*

**Funding**

1. **Substantial increase in Government R&D expenditure since 2007**
   - "New architecture" of the science system (High-tech Strategy; Excellence initiative)

**2. HEI financing: closer co-operation of federal and Länder governments**
- Share of Federal R&D expenditure increased to 57% in 2012
- 2014: Liberalization of the "co-operation ban" in the constitution: The Federal Government can now finance HEI more continuously.

**3. Project-based funding: shift to priority areas**
- Addressing societal and global challenges.
- Increasing the importance of complex programmes (cluster, network development).

**Policy findings:**

- Different approaches towards the KT are partly caused by the differences between a general university and a university of applied sciences.
- Other factors play an important role in the positioning of the HEIs in the KT:
  - (1) Historical paths and the structure of the innovation system (what firms, other HEIs, or PRIs are in the region?);
  - (2) Länder policies and strategies that foster certain paths of development of the HEIs in and with their regions
  - (3) Strategies and perceptions of the acting persons both in the relevant Länder ministries and HEIs; and
  - (4) HEI policies at the federal level (e.g. the excellence initiative).

| Greece | Knowledge Triangle in Greece |
|---|---|

*Authors: Dr. Charalampos Chrysomallidis, Dr. Nikolaos Karampekios and Tonia Ieromninon, National Documentation Centre under the direction of Evi Sachini, National Documentation Centre, Greece.*

**Summary:**

The recent crisis, which led to the reduction of institutional funding to HEIs in Greece (the main performer of research) has forced HEIs to diversify the sources of funding and to reconsider their strategies and at the same time has given greater importance to third mission activities. Universities are exclusively public in Greece according to the constitution. As regards the linkages between the main RDI stakeholders, the share of the R&D that is performed by higher education sector and is funded by business sector is one of the highest among EU countries. The case study shows that interactions of higher education institutes with other KT-related actors vary. More specifically, HEIs have the strongest relations with research centres regarding research collaboration in scientific fields of common interest, mobility of academic staff and students, etc. These interactions are structured on an *ad hoc* basis that relies on territorial parameters, mostly being the case in regions beyond the capital region of Attiki. In addition, research teams in HEIs have important linkages with international academic community, partly as a result of their strong participation in EU R&D projects. More formal channels of industry-science relations such as technology transfer office, suffer from a lack of institutionalization due to funding gaps. Furthermore, EU Structural Funds and the Smart Specialisation Strategies are steering the priorities of HEISs towards third mission and engagement with the business sector.

**Funding and governance arrangements**

The Ministry of Education that determines operation matters such as recruitment, payroll, students' enrolment, etc.

A certain degree of autonomy for higher education institutes can be observed in dealing with academic and managerial issues (e.g. structure), yet they rely heavily on institutional funding from the Ministry. The severe reduction of the latter to more than 45% has led to a major change in HEIs' attitude towards seeking alternative, non-institutional –and diverse sources of funding. As far as institutional initiatives supporting the knowledge triangle are concerned, NSRF 2007-2013 has funded the establishment of the Innovation & Entrepreneurship Unit (IEU-MOKE) in all HEIs, aiming at integrating research, education and innovation, for instance via seminars, presentations and mentoring on entrepreneurship, etc.).

**Understanding of the Knowledge Triangle**

In this new context, HEIs reconsidered their strategies intending on broadening their activities, running against past dominant perceptions which focused on education and research, offering mostly theoretical and general knowledge. Although the definition of a clear, a general rule is not easy, as some HEIs or even specific faculties may be more "business-friendly" or facilitate linkages with the business sector, than others, the dominant perception has not come in terms with HEIs' "third mission" or the third dimension of the "knowledge triangle" scheme.

Therefore, it is widely accepted that gap between academia and the business community should be further reduced in terms of R&D collaboration, mobility, spin-offs, etc. In line with this, it is not surprising that HEIs' external evaluation committees often highlight the need to foster business and entrepreneurship closer to HEIs.

**Place-based dimension**

Local embeddedness of HEIs varies. To start with, and even in in Regions that are non-R&D intensive, the level of embeddedness into the social fabric is important, for example via the housing and infrastructural amenities. Furthermore, there is usually a high rate of domestic students' enrolment in local HEIs, while HEIs care for local societal challenges, as expressed by local authorities via requests for planning and consultative services. Furthermore, Regional Operational Programmes –operated by Regional authorities within the framework of NSRF- finance RDI-related investment requested by local HEIs, research centres, etc. It is expected that this interaction will increase due to the implementation of smart specialisation strategy**.**

**Institutions surveyed:**

- University of Crete (UoC): One of the largest regional universities, covering humanities, social sciences, S&T and medicine. The UoC has a long tradition of collaboration with the Foundation of Research & Technology (FORTH), the public research centre of Crete, where mobility and scientific interface are significant. UoC participates in the Crete Innovation Initiative, the Science and Technology Park (STEP-C) incubator and has established strong interconnections with the Regional authorities.
- AUTh is elaborating on an institutional strategy facilitating the transition from knowledge to innovation, in addition to having established strong interrelations with the Regional authorities and participates in a pre-incubator establishment of the Municipality of Salonika for entrepreneurship development (OK!Thess).
- Athens University of Economics and Business (AUEB): One of the oldest universities, with a strong tradition in the fields of Economics and Business that has recently broadened its scientific areas (informatics, statistics).

- Aristotle University of Thessaloniki (AUTh): The largest university in Greece, including a wide range of faculties (hard sciences, humanities, engineering, etc.). R&D intensity (total R&D expenditures as a % of total budget) in these HEIs range between 25% and 40%.

AUEB stands as the first Greek HEI that introduced courses in entrepreneurship and implemented a strategy for "Innovation and Entrepreneurship" since the early-2000s. Its main tool for supporting third missions is the Athens Centre of Entrepreneurship and Innovation (ACEin), the University's incubation centre.

| Hungary | KT enabling policy |
|---|---|

**Summary:**
The Hungarian case study focused on a broad range of policy measures to strengthen KT at all levels.

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A large number of national strategies addressing R&I issues have been adopted in recent years that acknowledge R&I as a key driver and policy instrument for enhancing competitiveness and growth. These strategies have been strongly driven and inspired by the EU context (e.g. the new Horizon2020 and other new policies adopted for the new programming period 2014-2020) and have a broad coverage of relevant R&I issues. They are also based on a multi- annual planning, which is expected to improve planning and predictability of funding. A formal dimension of regional innovation policy has been introduced by the National Smart Specialisation Strategy (S3).It brings about a focus on current or emerging regional R&I strengths and also tests some soft instruments for innovation financing, like pre-commercial procurement (PcP) and two pilot measures for strengthening University-Industry links. An emphasis on R&I that goes beyond science and technological research into the development of an innovative ecosystem has been introduced by the National RDI Strategy and is supported in particular by the EU Economic Development and Innovation Operational Programme (GINOP).

**KT related policies**

The programme "Start-up_13" launched in 2013 aims at developing the Hungarian start-up ecosystem, in particular by supporting technology start-ups exploiting R&D results which have the potential to grow into dynamic international firms. The programme operates in two stages: 1) technology incubators and accelerators hosting technology start-ups are accredited, 2) most promising technology start-ups are selected in view of incubation and enabling them to enter and grow on international markets.

Two specific pilot measures that address University-Industry interaction ("Open laboratories" and "Higher Education and Industry Collaboration Centres" (FIEK) are foreseen in the National Smart Specialisation Strategy, published in November 2014. Another measure that supports the establishment of 8-10 "Knowledge Parks" in collaboration with local governments and universities was adopted in December 2014. In the programming period 2014-2020, the Economic Development and Innovation OP (GINOP), in particular Priority 1 supports the improvement of SMEs' competitiveness by the establishment and further development of business incubators with an indicative budge to of EUR 30 million. In addition, GINOP also foresees the further development of industrial parks and science parks. It is also important to mention here that the Hungarian Intellectual Property Office (HIPO) collaborates with university TTOs and Chambers of Commerce in almost all counties for supporting the operation of PATLIB centres that offer IP consultancy services and IP training to researchers and local SMEs. Entrepreneurship, education and training in university are limited to an elective course

There is a clearly stated policy focus on the development of TT and technology start-ups initiated in 2013 and continued in 2014, which is supported by the funding from the Economic Development and Innovation OP (GINOP) to SMEs' competitiveness, business incubators, industrial parks and science parks. It is, however, too early to see visible effects in the R&I system.

**Key measures to promote KT activities**:

- Budapest Runway 2.0.2.0.–A Start-up Credo" published in November 2013, envisioning Hungarian capital as the start –up centre of Central and Eastern Europe, Four types of measures for building a competitive start-up and innovation ecosystem are proposed: i) education and training, ii) access to funds, iii) taxation and regulation, iv) enabling environment
- Law on "Scientific Research, Development, and Innovation" supports the RDI-driven competitiveness of companies and the creation of high added-value jobs, while the new Higher Education Strategy includes measures to foster collaborative RDI activities between HEIs and companies, as well as tailoring the curricula toward the needs of the business sector.
- The New National Programme of Excellence (NKP) helps to make the researchers career more attractive. NKP is to be financed from central budget; in 2016, the amount to be allocated to scholarships is HUF 1.32 billion.

**Policy lessons:**

- KT targeted policies need to reflect a broad spectrum of stakeholders and initiatives
- A balanced STI policy approach is needed
- Hungarian policies are very much in line with European policy initiatives which imposes a threat of mainstream policies instead of targeted place based policies

| Ireland | Strategic dialogue and Regional Clusters |
|---|---|

**Summary:** The Irish higher education sector has a central role in the knowledge triangle by providing skills, facilitating technology transfer and commercialisation, and enhancing wider societal impact of education and research through an engagement agenda. The case study covers these and reviews key national policy initiatives and current institutional practices in three HEIs.

***Authors:*** *Ruaidhri Neavyn, Higher Education Authority Ireland as part the HEInnovate country review Ireland*

**Funding**

The Higher Education Authority's funding model that has three main elements: (i) an annual recurrent grant that is allocated to each HEI based on known formulae relating to the number of students and their subject areas, (ii) performance related funding that is allocated to HEIs based on benchmarked performance in delivering on national objectives, (iii) targeted/strategic funding that supports national strategic priorities and which may be allocated to HEI on a competitive basis. As a signalling measure, a limited amount of performance funding of EUR 5 million was reserved from the allocation of the 2014 recurrent grant to higher education institutions to be released subject to satisfactory engagement with the strategic dialogue process. This part of the funding model is expected to account for up to 10% of annual funding in time.

RDI activities in HEIs are funded through competitive funding. Core funding covers the salaries of core academic and support staff engaged in RDI activities as well as some recurrent costs associated which such activities. A national 'research prioritisation' exercise in 2011/12 identified 14 priority areas for research funding. The choice reflects an overwhelming importance given to STEM (Science, Technology, Engineering and Mathematics); apart from modest opportunities available through the Irish Research Council, researchers in non-STEM fields are expected to look outside the country for funding. Directing requests to multiple funding agencies also increases the share of resources spent on administrative staff and procedure costs and reduces investment in innovation.

**Key national policies**

The national strategy for higher education recognises that engagement takes many forms. It includes engagement with business and industry, with the civic life of the community, with public policy and practice, with artistic, cultural and sporting life and with other educational providers in the community and region, and it includes an increasing emphasis on international engagement. The strategy further recognises the multidimensional nature of many of the social, economic and civic challenges which will require inter- and multidisciplinary approaches, and that HEIs are uniquely well placed to lead, develop and apply these.

A central role in strengthening the role of HEIs in knowledge triangles plays the strategic dialogue and performance compact agreements. The purpose is to align the missions, strategies and profiles of individual higher education institutions with national priorities, and to agree strategic objective indicators of success against which institutional performance can be measured and funding can be allocated. The strategic dialogue process involves annual meetings between the executive of the HEA (supported by independent national and international experts) and the executive of the individual higher education institutions at which their performance compact submissions and progress against targets are discussed and assessed in detail.

Key policy initiatives to enhance skills development and reskilling include the Springboard program, which offers the unemployed free degree programmes to reskill and return to work, and the ICT Action Plan which will have doubled the output of Bachelor and Diploma graduates, also from conversion and reskilling programmes, by 2018. At a regional level, Regional Skills Fora, recently introduced by the Department of Education and Skills, are expected to provide robust labour market information and analysis of employer needs, better alignment of education and training provision with the skills needs of each region and enhanced progression routes between further and tertiary education. This builds on the Regional Cluster initiative, which has started almost a decade ago as HEI-HEI collaboration. In the five clusters (Dublin/Leinster I, Dublin/Leinster II, West/North West, The Shannon Consortium, and the South) significant progress was made in academic planning and student pathways. Regional Clusters, which have taken advantage of already existing collaboration structures were better prepared to meet the challenges of implementing reconfiguration and rationalisation measures and developed at a faster pace.

Commercialisation is enhanced by Knowledge Transfer Ireland, whose role is to maximise innovation from State-funded research by developing the knowledge transfer system; a national protocol for the commercialisation of intellectual property developed in HEIs is in preparation. The Technology Transfer Strengthening Initiative by Enterprise Ireland funds technology transfer infrastructure and targeted support measures in HEIs. Currently, a more-regionally and locally tailored approach of the Enterprise Ireland initiatives is underway.

**Institutional case studies**

- Translating research into real world applications
- **The Limerick Institute of Technology (LIT**) is the

drives the activities of the approximately 13 000 students and 1 300 staff at the **University of Limerick (UL)**. UL's role and leadership in partnerships with multinational corporations and local companies in pharmaceuticals, agrifood and software has been widely recognised for its innovativeness. UL's new strategic plan – Broadening Horizons – seeks to underpin these achievements by building a culture of entrepreneurship and innovation in staff and students alike. UL has commenced with the development of case studies on research impact and has brought together groups of researchers from different faculties and worked with them in order to develop an understanding of "what" impact is and "how" it can be measured. It includes the preparation of case studies and stories about the impact of some of the research at the institute and, how and where this can demonstrated, for example by translating research findings into practical guidelines and tracking the practical implications of using those guidelines on developments in policy design and implementation. Training is offered and templates are available to raise impact awareness and thinking when formulating research activities.

- **University College Cork (UCC)** is a research-led university, which punches well above its weight and successfully attracts high quality researchers and multiple sources of funding. Its five research areas are derived from the National Research Prioritisation exercise. To enhance research collaboration with local SMEs, the vice president for research and innovation regularly organises events for local firms to learn more about and get involved with UCC research, and in particular H2020 projects. A notable initiative to enhance the translation of UCC research into local development is CARL, the Community-Academic Research Links initiative. Since 2010 important pieces of research were produced and implemented, some of which have impacted on national public policy. CARL researchers work with non-profit voluntary and community organisations on a range of research topics. Selected research projects are intended to result in practical applications. One example of this is a checklist for Munchausen Syndrome patients, which can be used by family members and care personnel as a first diagnosis tool. As part of the research agreement, students, community partners and the UCC academics agree that completed research reports are posted online. CARL is now extending its activities within all four colleges.

fourth largest IoT in Ireland, with more than 6 000 full time and part time students and 600 staff on five campuses within a 100 kilometre radius of Limerick. Plans to expand the main campus are underway. Applied research in conjunction with local and regional business is one of LIT's strengths. LIT has the largest Art and Design school outside of Dublin and is a major partner in the City's application to be the EU's Capital of Culture. LIT's education and research activities both set and respond to local demands; one example of which is LIT's part time ICT conversion programmes for engineering students. LIT operates a 'One Stop Shop' customer relations management system to respond, track and deliver student services. LIT and UL are key drivers of the Shannon Consortium which was created in 2007, involving local community and businesses, city and county councils. The Shannon Consortium is regarded as one of the most, if not the most successful examples of a Regional Cluster. The Chairperson of the Shannon Consortium is a retired senior civil servant and former diplomat from Limerick City, and not being associated with any of the partner HEIs, facilitates better decision making in the consortium. The impact of the Shannon Consortium is significant. For example the multinational company Northern Trust would not have chosen to locate in Limerick without the consortium being in place, which enabled fast response times to the development of staff training programmes, the provision of office space etc. This has led to 400 new jobs being located in Limerick.

**Policy lessons:**

- **Co-ordination of the policy structures responsible for higher education, research and innovation and broadening the scope for non-STEM areas in research priorities**. The sharing of policy and funding responsibility for knowledge triangle activities in higher education across two government departments may lead to competing policies and overlapping funding instruments. To avoid this, it will be important to consider a consolidation of funding into a small number of agencies and a high-level coordination committee to prevent gaps, in particular with regard to non-STEM research or duplication.
- **Support HEIs in Ireland in creating collaborative and mentor links with entrepreneurial HEIs abroad**. Individual HEIs or groups of HEIs within Ireland should consider creating strong collaborative and/or mentor links with HEIs abroad that are advancing and embedding entrepreneurship and innovation within their strategies and practices. There is a role for public policy in facilitating peer learning in a systemic approach rather than single HEIs building their own links.
- **Enhancing Regional Clusters.** To achieve the overall aim of the Regional Clusters to strengthen research capacity and capability, promote enterprise and innovation, and to attract and retain talent from home and abroad, a next phase in the Cluster development will be needed, in which the focus is on including knowledge producers other than HEIs, and knowledge users and transformers from businesses, industry and civil society. Entrepreneurship and innovation should be considered as a core action area within the Regional Clusters. The recruitment of experienced personal from industry in full time or adjunct lecture positions should be considered to strengthen the capacity of HEIs to innovate and to generate entrepreneurs. A "one-size-fits-all model" should be avoided and buy-in from all involved HEIs ensured. For this guaranteeing full institutional autonomy and valuing the contributions of individual HEIs will be essential. Sharing good practices between the Regional Clusters is recommended.

| Italy | Fostering the third mission at universities |
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**Summary:** Over the last decades, the 'third mission' activities of HEIs have attracted an increasing interest from policy makers, due to their role in boosting innovation, fostering economic growth and creating new jobs. In Italy, the commitment of comprehensive universities to third mission activities (usually conducted by the polytechnics) is relatively recent, as demonstrated by the fact that it has been officially mentioned in university legislation only at the end of the 1990s. However, the response from universities has been very favorable.

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**Policies for third mission activities at Italian universities**

To raise awareness of third mission activities, an association "NetVal" (Network for Research Valorization) was established in 2001 to collect data on third mission activities and to analyse Italian technology transfer in order to share best practices, and provide guidelines to Technology Transfer Offices (TTOs). NetVal is also active in training university administrative staff and supporting policy makers. This association currently includes 60 Italian universities. Therefore, is not surprising that these activities have not been properly evaluated, nor have been recognized (for funding) by the central government. Very recently, the National Agency for the Evaluation of University and Research (ANVUR), established in 2010 (Decree 76/2010) has included third mission activities among the objects of its evaluation. By assessing third mission activities, ANVUR aims to highlight the role of universities in shaping innovative ecosystems. Metrics used to assess their contribution to economic development also include revenues and the number of jobs created. ANVUR stresses the relevance to promote aggregation between universities in order to create a critical mass, sharing services and attract business community. On the other hand, it is worth noting that some regional HEI aggregations are emerging. A recent example is the JoTTO initiative (Joint Technology Transfer Office), which aims to promote the development processes of research of the School IMT Lucca, the Scuola Normale Superiore and the Scuola Superiore Sant'Anna.

**Funding**

In Italy, research and higher education are largely publicly funded. The major public source of funds for universities is based on block funding by the Ministry for Education, University and Research (MIUR), the FFO ("Fondo di finanziamento ordinario"), which covers the personnel salaries (80% of the FFO, on average) and the basic running costs. An increasing proportion of the public funding (currently 20%) is performance-based. Most research funds come from other public (regional, transnational, international) and/or private sources. Public funding by MIUR and by the Ministry for Economic Development (MISE), together with the regional administrations, supports university-industry cooperation using also the European Structural and Investment Funds (ESIF), e.g. by promoting the creation of National Technology Clusters. The plurality of actors may give rise to coordination problems (see next paragraph).

**Place-based policies**

In Italy, policy initiatives to promote KT are largely managed separately by MIUR, MISE and Regions. The lack of a co-ordinated and integrated policy mix affects negatively the efficiency and effectiveness of KT activities, creating overlaps among policy interventions, favouring fragmentation and unnecessary duplications. The main reason is that at central level, the Regions interact with the MISE, while at local level, for the place-based policies, the Regions interact with the Universities, which operate under the aegis of the MIUR. A shift from policy measures largely focused on the supply side (i.e. research facilities, science parks, patenting) to demand side focused policy measures, as e.g. the institution and strengthening of the National Technology Clusters, might possibly solve these problems by constituting an integrated policy framework to boost KT activities in Italy.

**Relation between national practices for the evaluation practices for higher education and research funding and the KT**

ANVUR is devoting its efforts to understand the role of Italian universities and public research organisations in their geographical contexts by evaluating their economic, social and societal outcomes. The first evaluation exercise considered the time span 2004-2010, when ANVUR, besides the 'conventional' research output, assessed also academic patenting and academic entrepreneurship (even though these activities did not influence in the allocation of FFO). The second evaluation exercise, covering the period 2011-2014, in addition to the usual evaluation of research, involved both research exploitation, and activities related to the production of public goods. The former included indicators as: a) patents (disclosure, inventors, patent portfolio strategies, licensing); b) spin-offs (revenue, number of jobs created, exist strategies, cooperation with labs, growth paths); c) services to third parties (research, teaching, etc.); d) knowledge intermediaries (technology park, incubators, tech transfer offices). The production of public goods included metrics on the following areas: a) production and management of cultural heritage; b) clinical trials, research infrastructures and medical training; c) lifelong education; d) public engagement. The third mission assessment run by ANVUR is explorative in nature and provides stakeholders with qualitative and quantitative information on university KT activities and public goods production. This

broader third mission framework, compared to the US model (licensing & spinoffs), is also consistent with the digital transformation, which allows the emergence of new phenomena (such as, e.g., science crowdfunding). Overall, ANVUR intends to gain a deeper understanding about third mission strategies that universities are deploying and the governance changes required to achieve their respective goals. In the next years, information will be systematically collected through a web platform managed by the Italian main data management infrastructure (CINECA), so to help universities to enter all the information needed to present qualitative and quantitative dimensions characterizing the third mission. These findings will not immediately impact on ministerial (MIUR) funds allocation, but will support universities in gaining a clearer picture of the diverse activities in which they are engaged. Moreover, the systematic and comprehensive collection of information on third mission activities will help shed light on differences across disciplines and socio-economic contexts.

| Japan | Knowledge Triangle at Kyoto University |
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**Summary:**
In Japan, the large share of business R&D performed that characterizes Japan's innovation systems has focused attention on the role of HEIs in producing human capital to meet the needs of a high tech and medium tech export based industry.

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*Kobayashi Yusuke, Kyoto University, Research Administration Office, Research Administrator, Japan*

**HEIs surveyed:** One comprehensive university, Kyoto University, was surveyed.

**Examples of programmes at Kyoto University to support KT activities**

- *The Graduate School of Advanced Integrated Studies in Human Survivability (*GSAIS), a completely new type of graduate school based on a programme for leading graduate schools entitled "Schools of Advanced Leadership Studies" (SALS). SALS were selected for the Programme for Leading Graduate Schools (All-Round Model) project by the Ministry of Education, Culture, Sports, Science and Technology - Japan (MEXT) in April 2011. The target profile for a graduate student is an individual who is willing to assume responsibility as a global leader and an entrepreneur. This programme is nicknamed "Shishu-Kan", as it is the field (Kan) to create knowledge and entrepreneurship by thinking (Shi) and practicing (Shu). Internships, fieldwork, and project-based research are important course requirements. The students also undergo one-year overseas internship with an international organization. They live in a residential college on campus, which enhances the environment for learning by facilitating student interaction across disciplines, and professors are available onsite to provide necessary support and mentoring. Further, eligible students receive a scholarship from the University as well as a financial support for their research activities.
- *The Graduate School of Management" (GSM),* established in April 2006 differs from the conventional graduate programme which to educate advanced professionals. GSM focuses on nurturing business leaders and entrepreneurs with highly specialized and advanced knowledge in various fields, by utilizing the knowledge acquired through research and university education.
- *Office of Society-Academia Collaboration for Innovation (SACI),* established in 2007, aims to provide a one-stop shop for companies who are interested in collaboration with Kyoto University. SACI provides up-to-date information on technology developed by Kyoto University at various stages, i.e. not only research results such as patents but also technology which is in the process of being researched. SACI supports various collaborations with the help of external organizations such as TLOs (Technology Licensing Organizations). A Venture support programme promotes entrepreneurship education in the University community. The Venture Support helps Kyoto University inventors, innovators and entrepreneurs make their ideas and concepts more commercially successful for the benefit of society, the Japanese economy, the inventors and the University. Furthermore, Venture Support promotes funding to entrepreneurs through linking Kyoto University Venture Fund (KUVF) to entrepreneurs. KUVF was established in 2007 with a mission to provide funding to promising start-ups related to the Kyoto University.

**Placed policies for HEIs**
The Kyoto Innovation Belt (KIB), consists of 15 campuses of universities, 11 incubation facilities, and 13 industrial zones (IZ) and is spread over 40 km (North to South) and 12 km (East to West) and almost the same size as Silicon Valley. The KIB is supported by Kyoto City as well as Kyoto Prefecture. Kyoto University has been working as main sources of scientific / technological knowledge as well as intellectual human resources for KIB. One of the Kyoto campaus, the Katsura Campus includes the Katsura Venture Plaza an incubation facility that was established by the collaboration of Kyoto University, Kyoto City and Kyoto Prefecture as well as the Organization for Small & Medium Enterprises (SME Support) in 2004.

**Policy lessons:**

- The government implemented the TLO Act in 1998, and established High-Tech Innovation Centres (32 centres), as a policy for industry-academia collaboration. Under the Industrial Competitiveness Enhancement Act, when a venture capital firm or other business intends to provide management consulting or funding services to university-based start-up venture businesses and other entities that make use of research results that national universities and other
- In one instance, such efforts resulted in 813 research collaborations by Kyoto University and Yen 5.6 billion in funding during the fiscal year 2009. In the fiscal year 2014, the numbers reached 1010 cases and about Yen 7.9 billion. The contract amount has increased by 40 percent. These research collaborations have improved the productivity of company and the quality of education. The increase in the number of university–oriented ventures will be able to provide social value

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| | institutions have produced (support programme for utilising specified research results), it may submit a business plan concerning the service to the Minister of Education, Culture, Sports, Science and Technology, and the Minister of Economy, Trade and Industry in order to receive official authorisation for plan. Entities which are authorised as support entities for start-up venture businesses utilizing specified research results are eligible to receive human-resources and technical support from national universities and other institutions. (It should be noted that when national universities intend to fund such venture businesses, they are required to receive approval from the Minister of Education, Culture, Sports, Science and Technology). | by utilising specified researches in universities.<br>• The result of above policy and cases shows that the exchange of knowledge activated by agglomeration of universities and industries affects the local economy, education and research, and accelerates innovation. |

| Korea | Place-based Innovation Policies and the role of Higher Education Institutions |
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**Summary:**
Diverse KT-related practices are found in the Korean universities, which are driven by the Korean government's policies to foster University-Industry cooperation, although the concept of “Knowledge Triangle” is not widely used in Korea.

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**KT related policies:**

The Korean government has promoted strong innovation policies, however, universities has not played a critical role in the industrial innovation until the 1990s. Instead, the Government Research Institutes (GRIs) have developed technologies necessary for industrial innovation through applied research, and the role of universities was limited to that of higher education until the early 1990s. Korean universities began to conduct research activities with the increase of R&D funding from the national government in the 1990s.

Since the 1990s, The Korean government has promoted a university-industry collaboration policy and supported universities to contribute to industrial competitiveness and national development through their research and education. The policy and laws that promote technology transfer of universities had been established, and the national government began to actively support projects that transfer research result into private area. In the early 2000s, the Act on the Expansion of Industrial Education and the Promotion of University-Industry Collaboration was established, and, University-Industry Collaboration Units were established as a form of a separate corporation in each university. And the University-Industry cooperation policies expanded to include changes of university education to respond the demands of industries. More recently, entrepreneurship education is emphasized in many Korean universities and supported by the government's 'creative Economy' policies.

**Place-based policies and HEIs**

Traditionally, the role of Korean universities did not include a regional dimension. In the late 1990s, the Korean government started to promoted regional policies for balanced development. Population and industrial innovation were concentrated in the capital region whereas innovation capacity was scarce in the rest of the country. Universities are relatively equally distributed across the country, and the Korean government supports universities to play a major role in knowledge creation in each region (especially less developed regions). However, the regional engagement of universities is still limited.

**HEIs studied:**

- Korea Advanced Institute of Science and Technology (KAIST) is a specialized science and technology university supervised by the Ministry of Science, ICT, and Future Planning.
- Chonbuk National University is a national comprehensive university located in a less industrialized region.
- Jeju National University is a national university located in the largest island of Korea, which is the 'Special Self-Governing Province.

**Main policy programme**

The Leaders in Industry-University Co-operation (LINC) programme supports universities (1) to improve the university education system and to resolve the job mismatch dilemma through university-industry co-operation; (2) to expand the scope of university-industry cooperation as one of the major activities of universities along with research and education; (3) to respond to the demand of regional industries. The Ministry of Education provided KRW 201.2 billion (Euro 152 508 584) to 19 universities in 2014.

**Policy lessons:**

- The University-Industry cooperation policies driven by the Korean government have brought a limited accomplishment; however, they provided Korean universities a momentum to recognize the significance of the third role of HEIs.
- Each university has a specific condition in which they can contribute to regional development. Bottom-up leadership and strategies are as much important as top-down policies and guidelines.

| **Netherlands** | **An Entrepreneurial eco-system approach to the KT** |
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*Authors: E. Stam, A.G.L. Romme, M. Rosso, Van den Toren, B.T, Van der Starr, Utrecht, Eindhoven and Birch Consultants, Netherlands*

**Summary:**
The case study focuses on research-education-innovation dynamics within Dutch entrepreneurial ecosystems. Any knowledge triangle does not evolve in a vacuum, but is part of a broader set of interdependent actors and factors which, if coordinated in an adequate way, might enable productive entrepreneurship within a particular territory. This report focuses on the role of regional governance (i.e. networks and leadership) in the knowledge triangle and the entrepreneurial ecosystem more broadly.

**Funding**
The Dutch innovation support system relies heavily on tax incentive schemes for R&D assets and labour costs; it does not invigorate cooperation. More than 22 000 firms made use of these incentives in 2014 (Ministry of Economic Affairs, 2015). Data on these schemes are not public and have not been taken into account in the case study. Most of public R&D stimuli are technological in nature. The European Framework Programme covers a wide variety of subjects, whereas most Dutch incentives are related to the Top Sector Policy, involving strongly technology-driven sectors. In terms of absolute numbers and financial size the innovation projects are skewed towards the European programmes: nearly half of the projects have a European public financial source.

**Place-based policies**
The performance of knowledge triangles embedded in (entrepreneurial) ecosystems is highly conditioned by local and historical factors — such as culture, formal institutions, physical infrastructure, financial resources, and the available pool of talents. The knowledge networks provide connection in such an ecosystem, whereas leadership involves a mechanism for giving direction. Knowledge networks and leadership capabilities are two critical systemic conditions for entrepreneurial activity and value creation, but their role and impact cannot be isolated from the broader set of conditions.

**HEI institutions surveyed**:

- The Amsterdam, Utrecht, Brainport and South-Holland regions do not differ substantially with respect to the structure of their knowledge networks, all having better scores than the national average.
- The network characteristics of the Twente region are, however, significantly different (e.g. more dense and connected) than those in the other four regions.
- The knowledge networks in Amsterdam are dominated by a larger set of HEIs. In the Brainport region two large OEMs as well as two HEIs are central.
- The Amsterdam, Brainport and Twente regions have been developing 'triple helix' forms of regional governance, involving an ongoing dialogue between key stakeholders.
- However, these three regions are also demonstrating distinct patterns and abilities. The three regions differ significantly in how they (as an entrepreneurial ecosystem) are configured, and therefore also face fundamentally different challenges in terms of economic growth, competitiveness and employment.

**Policy Lessons:**

- A collective sense of urgency about the local economic situation is a critical condition for initiating a strategy for geographical clustering and co-location.
- Each region has a unique history in shaping collective action, and has also been developing a (region-specific) balance between top-down steering and bottom-up leadership.
- The three case studies suggest there are substantial differences between regional boards, with regard to their ability to choose where, when and how to act — especially as a result of how they are funded and organised.
- Overall, entrepreneurial ecosystems emerge and develop in highly specific historical, social and geographical settings.
- As such, there is unlikely to be a single-best solution for shaping and governing (the development of) entrepreneurial ecosystems, and local governments and other agents should therefore be very careful and cautious in any attempt to copy 'best practices' observed in other regions.

| Norway | The knowledge triangle in policy and institutional practices |
|---|---|

**Summary:** There is a strong policy focus on research-based innovation and commercialisation of research, and hence on inter-linkages between research and innovation. In addition, entrepreneurship education has been a priority. While these are still considered important areas, the contribution of education to innovation more broadly is gaining increasing attention in policy, along with inter-linkages between research and education activities in higher education institutions. The majority of HEIs are state-owned, and although innovation is seen as important in policy and by governmental agencies, the state in its governance of HEIs mainly emphasizes research and education, which conditions HEIs potential for integrating education, research and innovation.

*Authors: Borlaug, Siri, B., Aanstad, Siri and Solberg, Espen Nordic Institute for Studies of Innovation, Research and Education (NIFU), Norway.*

**Funding**

At the national government level, the so-called "sector-principle" means that the ministries are responsible for research and innovation within their respective sectors, and this poses challenges in terms of horizontal coordination between the ministries. The Ministry of Education and Research has the overall responsibility for coordinating Education and R&D-policies, while the Ministry of Trade and Fisheries coordinates innovation policies. One research council, the Research Council of Norway (RCN), covers all research disciplines and sectors, and also provides support for industrial R&D and research based innovation. It also has the mandate to advise the government on research policy and to facilitate networking and communication between different actors in the Norwegian research and innovation system. The rather unique model of having one research council embracing all disciplines and forms of R&D means that the science-innovation link is embedded in the institutional set-up. In parallel, the national innovation agency, Innovation Norway, promotes innovation, entrepreneurship and business development through a number of measures, some of which are related to R&D. This means that funding programmes for strengthening the interplay between research and innovation are many, but few support the integration between education and innovation. The public agency responsible for higher education (NOKUT) has a more specialized focus on quality assurance and is less important in terms of funding of higher education. Hence, on the policy and agency level, the links between education policies and research and innovation are less developed.

In general, Norwegian higher education institutions are mainly financed through public block-funding allocated from the Ministry of Education and Research. This funding stream covers almost all higher education activities, while R&D-activities are financed with around 2/3 from public block funding and 1/3 from external funding (primarily RCN). Another feature of funding of HEIs is that direct industry funding is relatively modest, accounting for 4% of HEIs' total R&D expenditure. Additionally, there are few private donors and research foundations.

**Observations from the institutional case-studies**

- *UiT The Arctic University of Norway*: Comprehensive university: strong regional mandate academic university locally embedded, strong ties to the public sector, regional industry small and geographically dispersed, new types of adjunct positions involving public sector and industry
- *The Norwegian University of Science and Technology*: a technical university: national mandate with strong ties to industry and the public sector innovation «anchored» in the management «vice-rector for innovation»; well-developed eco-system for commercialization and entrepreneurship, co-operation with industry on education, but tensions between the tasks; few incentives for cooperation with industry and commercialization.
- *Buskerud and Vestfold University College*: a regional university college: regional mandate integrated ties with industry and public sector co-operation on strengthening education, innovation and research, cluster-programmes important for developing KT-practices, new types of adjunct positions involving industry.

**Policy lessons:**

- The policy areas are largely managed separately. One consequence is that it limits the HEIs possibility to integrate KT-activities.
- A strong policy environment and dedicated sector ministries provides good opportunities for an integrated approach to KT-activities
- Long term funding is important for developing and institutionalizing co-operation structures between HEIs and public/private actors. It offers the possibility to work strategically to strengthen interaction between education, innovation and research.
- The availability of local flexible funding, characterized by short-term application and decision processes, may offer a possibility for researchers to explore potential innovative ideas together with industry or the public sector, which may further develop into larger KT-projects.
- New types of adjunct positions and expanding the use of dual affiliations can enhance knowledge exchange and facilitate KT-practices.
- Academic career systems can be used to incentivize KT-practices, by including innovation and education as promotion criteria.

| Spain | The AgriFood Campus of Excellence –ceiA3 |
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**Summary:**
To address the major challenges and weaknesses detected in the diagnosis of the Spanish university system made by Strategy University 2015, the CEI program was established to strategic co-operation and networking among universities and other research institutions and business placed within the campus, to develop university-centred knowledge clusters, acting as regional hubs of international excellence and contributing to the regional economic development, social cohesion and employment. The main objectives of CEI Programme were:

- To improve the international visibility of the best Spanish university campus through the promotion of strategic aggregations to reach critical mass and excellence;
- To promote the diversification and specialisation of universities;
- To promote the development of innovative regions whose economic development is based on knowledge.

The evaluation criteria included the appraisal of three transversal dimensions, mainly the quality and sustainability of the strategic co-operation (aggregation), internationalization and specialisation. The programme was supported by several departments of the Spanish Government, particularly the Ministry of Education and Ministry of Science and Innovation, which put in place a comprehensive effort to improve the quality of services, activities and initiatives of the Spanish Campuses.

**Authors:** *Luis María Delgado Martínez, Ministry of Education, Culture and Sports, Lola del Toro Jordano, ceiA3 and Fernando Mérida Martín, Ministry of Economy and Competitiveness, Spain*

**Funding**
The CEI Programme introduced a new funding instrument at institutional level to support new forms of co-operation – competition at national level among universities and other knowledge-related agents, around a new concept of university campus. The impact of the CEI programmes after three consecutive calls in 2009, 2010 and 2011 with selection of 32 CEIs and the monitoring and assessment of their progress by an International Commission set up by the Ministry of Education, Culture and Sport MECD in the period 2012-2015 has been demonstrated and recent studies even show an improvement in the average position of Spanish universities in the average and top position of global university ranking.

**Policy lessons:**

- The CEI programme allowed close co-operation between universities, other knowledge-related agents (research centres, scientific and technological parks) business, regional administrations and civil society organizations of the region.
- This integration of education, research and innovation in a given territory favours the creation of communities oriented towards excellence in specific knowledge domains, fulfilling the objectives of specialisation and, thus, the internationalisation of their activities.

## Sweden

**A knowledge triangle for quality and impact – Challenges for Swedish universities**

**Summary:** There is currently no explicit policy in Sweden targeting the knowledge triangle. Still, it is a political priority and a living concept rhetorically. There are a number of characteristics and developments in the Swedish university landscape and system that condition the way in which knowledge triangle principles are realised.

***Authors:*** *Sylvia Schwaag Serger Halmstad University and Technical Research Institute of Sweden (SP), Eugenia Perez Vico (Vinnova, Lund University) , Emily Wise (Lund University), Sienna Bankler-Jukes (KTH) and Mats Benner (KTH and Lund University), Sweden*

**Funding**

The central public funding streams for the three tasks of the KT are separated and isolated from one another, creating fragmentation and weak integration of tasks. In addition, Sweden's research funding system is characterized by a relatively large number of funding organizations, which creates further fragmentation. The funding system has targeted selected research groups or even individuals, while it has undermined the leverage of university management and its ability to exert strategic leadership (Jacob 2015). Resources and thus leverage are centred around and reside primarily with research groups or even individuals which have considerable independence and decision-making power. The result is that the ability for universities as organizations to act strategically and drive change is quite limited. Rather, changes occur through specific R&D programmes which yield effects that are limited to specific research groups or academic disciplines (Benner 2013). Thus, much of the steering power lay in the hands of research funding agencies and research groups.

**Industry-science relations**

During the 1970s and 1980s, a number of initiatives and policies created a more institutional approach to interaction with the surrounding society. Offices and publicly funded programmes aimed at promoting cooperation between industry and academia were set up. Technology parks emerged, as did other forms of 'intermediaries' or 'bridging functions' between academia and the surrounding society, with a strong focus on the business sector in general and technology-based firms in particular. An important threshold event occurred in 1998 when the government officially made cooperation with surrounding society one of universities' core missions. In the wake of this decision, public funds were earmarked and increasingly made available to universities for cooperating with industry. By 2013, the proportion of public funds to universities requiring collaboration had reached more than 11%. Interaction can also be argued to have been unsystematic and centred and revolving around certain individuals, groups or communities. Personal relations and path dependencies played an important role in these interactions.

**Observations from the Institutional Case Studies**

- **Lund University:** tension between the tasks, and the tension between the roles of central administration in relation to the faculties.
- **Chalmers University**: strong managerial tradition provides an example of an ambitious university by purposefully orchestrating the knowledge triangle through the introduction of a matrix organisation.
  Yet, tensions have risen as the new organisation has increased complexity. These tensions are identified both vertically from management level down to individual researchers, as well as horizontally between different university tasks (i.e. education, research and societal engagement). In addition, tensions stem from the diverse ways in which the knowledge triangle is interpreted, valued and employed.
- **Malmö University** has predominantly been oriented around education and vocational training, and its profile is highly education-driven. As a result, they have been pushed to find innovative ways of seeking external funding and expanding their research base, primarily through collaboration with the local community, either via industry, NGO and state sector partnerships.
  Malmö sees societal engagement as a core value that forms an identity of serving society, differentiating it from older and more prestigious traditional universities.
  Malmö is a national hub for social innovation and prizes its engagement with civic society. As such, collaboration and integrating education with research and innovation is almost part of Malmö's DNA, making specific 'models' such as the knowledge triangle obsolete in everyday parlance for staff.

**Policy lessons:**

- The policy areas of relevance to the knowledge triangle (research, education and societal engagement) are largely managed in silos
- The result is that the ability for universities as
- The specialised universities include the technical, agricultural and medical universities that all have long-standing 'natural' ties to related industries, sectors and networks.

| | |
|---|---|
| organisations to act strategically and drive change is quite limited.<br>• Much of the steering power lay in the hands of research funding agencies and research groups. | • Many universities have adopted strategies for cooperation with industry and society. This has also spurred changes in organisational structures, recruitment or other policies. However, there is broad variation in universities' approaches to establish a link between their strategies for societal engagement and their operational practices (in research and education). |

| **Russian Federation** | **Higher education policy and the knowledge triangle** |
|---|---|

**Summary:**
The Russian case study focused on the HEI development dimension at different levels of Russian higher education policy making and the role of governance mechanisms and new structures to involve HEI at regional level.

*Authors: Dirk Meissner, Anastasiya Narkhov, Higher School of Economics. Moscow, Russia*

**Funding drivers**

There are two main sources of funding education and research in Russia: budget and non-budget. Budget funding mostly allocated in a project basis. This scheme was launched in 2006 within the National Priority Project "Education". At the first stage 57 universities support to implement 2-year innovative education strategies. Total amount of government funding accounted for RUB 30 billion, and in addition those universities attracted RUB 8 billion from non-budget sources. In 2009-2014 Federal Universities received RUB 35 billion subsidies from budget, and earned RUB 15 billion in collaboration with business-partners, and providing educational services. National Research Universities received earmarked subsidies in total amount of RUB 49 billion, and RUB 20 billion from non-budget sources. The amount of non-budget funding depends on the university enthusiasm and activeness. Since 2007 all Federal Universities started to adopt the practice of Endowment Funds.

**Education policies**

In 2009 the Ministry of Science and Education launched a programme for developing a network of National Research Universities. This status was granted to 29 universities on a competitive basis after the two rounds of the selection procedure (in 2009 and 2010). The winners received access to the total budget of RUB 48,9 billion (in 2009-2014), and were obliged to receive 45 billion from off-budget sources for establishing university's innovation development strategies, creating new academic programmes, improving research infrastructure, rising academic mobility and enhancing professional competences of teaching and research staff. To maintain the status of a National Research University all participants must undergo annual efficiency evaluation process, based on the methodology and quantitative and qualitative indicators designed by Ministry of Science and Education. In parallel another policy for establishing Federal Universities was introduced (Presidential Decree № 718 07.05.2008 «On Federal Universities»), where the Federal University is a result of the university merger process on the regional level. Several (two or more) universities of different profiles (classical, polytechnic, pedagogical etc.) were united under the common transparent governance, received additional direct earmarked funding for the purpose of becoming centres of scientific and educational excellence, and more generally, national platforms for providing stakeholders with high value-added competences. The Ministry of Science and Education also claimed that Federal Universities will play a role as main drivers of regional economic development and innovation activities. These initiatives are based on the objectives to increase the level of engagement of university staff in R&D and academic entrepreneurship as well as to fulfil the demand of innovation economy for qualified professionals. The quantitative target to increase the GERD performed by universities to 13.5% by 2018 was set in the May (2012) Presidential Decree "On measures to implement state policy in the field of education and science" (No. 599). The main feature of Federal University governance is the obligation to establish a Supervisory Board as a peer public governance body. The Board is responsible for ensuring transparent procedures and favourable environment for strategy implementation aligned with regional economy specific and features and composed of representatives of regional/federal authorities, entrepreneur unions, forming industries, top level academic experts.

**Key measures to promote KT activities**:

- Government Decree №211 16.03.2013 «On measures to support leading Russian universities for the purpose to increase their competitiveness among the leading global centres of scientific and educational excellence»
- Government programme 'Development of Science and Technology in 2014-2020'
- Presidential Decree «On measures to implement state policy in the field of education and science (No. 599)» Presidential Decree №718 07.05.2008 «On Federal Universities»)
- Cluster policies in Russia

**Policy lessons:**

- HEIs' impact on regional innovation infrastructure is strengthened through the elaboration of innovation ecosystem around particular universities, active cooperation with regional industry and consultancy for business innovation development, building strong networks among other stakeholders of regional innovation processes.
- HEI have freedom to develop organically and apply state of the art HEI management models.
- HEIs' contribution to the regional STI development is determined by the growth of appropriate technical base (e.g. machinery and ICT resources), allowing creation of Centres of Collective Use and Centres of Engineering Excellence, where joint R&D activities are taking place. Federal Universities are engaged in Innovative Clusters through IP offices, TTOs, business incubators, centres for innovation competence training.

# ANNEX: METHODOLOGY FOR THE KNOWLEDGE TRIANGLE CASE STUDIES

## Structure of the case studies

The case studies were structured in two parts according to a common template. Part 1 consisted of a survey of national policies where respondents were asked to describe features of their research and higher education systems (a qualitative description) with respect to the four themes of the KT project: funding and governance, place-based policies, evaluation and impact assessment. Part 2 of the case study template was used by countries to perform detailed case studies of a diverse range of higher education institutions: A large, comprehensive university; a technical/science university; and an institution with a distinct regional profile. Part 2 surveyed the policies and strategies adopted at the institutional level have to promote the development of KT activities and practices. See below for detailed summaries of the institutional case studies.

### *Empirical materials*

National delegations executed the case studies according to a common template (Annex Table 1). While several countries closely followed the template, several countries chose to diverge from the template and took a thematic focus, notably as regard the issue of higher education institutions in place-based policies and open innovation networks.

**Annex Table 1. Template for the case studies on the knowledge triangle**

| **Nation policy frameworks for KT activities** | |
|---|---|
| Q1: The overall state of interaction between research, education and innovation (i.e. the knowledge triangle) | *Description of strategic initiatives at national/regional level to support knowledge triangle developments in higher education.* |
| Q2: What is the position of the higher education sector in the knowledge triangle? | *Description of the main channels, actors and current state of KT at HEIs.* |
| Q3: How is research and higher education funded? | *Description of the main funding sources for research and education and effects on KT interactions.* |
| Q4: The role of place-based policies in the KT | *Description of the local embeddedness on the HEIs and how this is reflected in policy strategies, governance and funding at institutional level.* |
| Q5: Relation between national practices for the evaluation practices for higher education and research funding and the KT. | *Description of the types of the criteria, measures and indicators applied to evaluating research and higher education funding and relationship to the KT.* |

*Source*: OECD.

### *Implementation*

Delegates contracted the case studies to policy analysts and academic researchers in the areas of research and innovation policy with expertise on higher education institutions. The country analysts

surveyed national policy documents on research and innovation strategies and programmes and the extensive documentation on higher education institutions. For part 2 of the case study template, interviews were conducted with decision makers at HEIs (e.g. rectors, deans, leaders for R&D centres and projects) as well as research institutes and collaboration partners. Case study leaders also analysed quantitative data on collaborative research funding at programme, project or institutional level.