Sociological Series
Working Paper No. 118

Higher Education Institutions and Knowledge Triangle: Improving the interaction between education, research and innovation

Lassnigg, Lorenz and Hartl, Jakob and Unger, Martin and Schwarzenbacher, Iris

March 2017

118
Reihe Soziologie
Sociological Series

Higher Education Institutions and the Knowledge Triangle

Improving the interaction between education, research and innovation

Lorenz Lassnigg, Jakob Hartl, Martin Unger, Iris Schwarzenbacher

INSTITUT FÜR HÖHERE STUDIEN
INSTITUTE FOR ADVANCED STUDIES
Vienna

118

Reihe Soziologie

Sociological Series

Higher Education Institutions and the Knowledge Triangle

Improving the interaction between education, research and innovation

Lorenz Lassnigg, Jakob Hartl, Martin Unger, Iris Schwarzenbacher

Revised Version: March 2017
(April 2016)

Institut für Höhere Studien (IHS), Wien
Institute for Advanced Studies, Vienna

Contact:

Lorenz Lassnigg
☎: +43/1/599 91-214
email: lassnigg@ihs.ac.at

Founded in 1963 by two prominent Austrians living in exile – the sociologist Paul F. Lazarsfeld and the economist Oskar Morgenstern – with the financial support from the Ford Foundation, the Austrian Federal Ministry of Education, and the City of Vienna, the Institute for Advanced Studies (IHS) is the first institution for postgraduate education and research in economics and the social sciences in Austria. The **Sociological Series** presents sociological research of the IHS and aims to share "work in progress" in a timely way before formal publication. As usual, authors bear full responsibility for the content of their contributions.

Das Institut für Höhere Studien (IHS) wurde im Jahr 1963 von zwei prominenten Exilösterreichern – dem Soziologen Paul F. Lazarsfeld und dem Ökonomen Oskar Morgenstern – mit Hilfe der Ford-Stiftung, des Österreichischen Bundesministeriums für Unterricht und der Stadt Wien gegründet und ist somit die erste nachuniversitäre Lehr- und Forschungsstätte für die Sozial- und Wirtschafts-wissenschaften in Österreich. Die **Reihe Soziologie** bietet Einblick in die soziologische Forschungsarbeit am IHS und verfolgt das Ziel, abteilungsinterne Diskussionsbeiträge einer breiteren fachinternen Öffentlichkeit zugänglich zu machen. Die inhaltliche Verantwortung für die veröffentlichten Beiträge liegt bei den Autoren und Autorinnen.

Abstract

A critical review of the feasibility of the concept of the knowledge triangle (KT) as a basis for policy is presented. The research shows a gap between policy discourses and academic research. KT appears as a policy driven concept with superficial plausibility, however, has not been much analysed and evaluated. As a concept for policy making the KT seems complex and poorly understood. Few concrete approaches of the KT were observable (the European Institute of Innovation & Technology EIT and the more conceptual European Association of Institutions in Higher Education EURASHE concept).
The analysis provides an analytical framework and proceeds by looking at the three two-way-relationships included, and then tries to draw extrapolations towards the three-way relationship indicated by the KT. A focus is the 'Third Mission' of universities, that has various, and partly contradictory meanings. A basic challenge is that the concept requires a turn from the ongoing differentiation process in higher education towards (re)-integration.

Zusammenfassung

Eine kritische Analyse der Literatur zur Tragfähigkeit des Konzepts des Knowledge Triangle (KT) als Basis für Politik wird präsentiert. Es zeigt sich eine Spaltung zwischen den politischen Diskursen und der Forschung. KT erscheint als oberflächliches politisches Konzept, zu dem es (noch) (fast) keine Forschungsergebnisse gibt, es wurden auch nur wenige Ansätze einer Realisierung gefunden.
Auf Basis eines analytischen Rahmens werden die drei involvierten zweifach-Interaktionen im Dreieck untersucht, und es werden Extrapolationen auf die Dreifach-Interaktion vorgenommen. Einen Schwerpunkt bildet die ‚Third Mission' der Universitäten. Eine wesentliche Herausforderung für eine KT Politik besteht darin, dass diese die vorherrschende Tendenz der Differenzierung im Hochschulwesen zugunsten einer (Re)-Integration der Funktionen ‚umdrehen' muss.

Keywords
Higher education, teaching, research, innovation, innovation policy

Schlagwörter
Hochschule, Lehre, Forschung, Innovation, Innovationspolitik

Acknowledgement

This paper was written as a commissioned contribution to the OECD Knowledge Triangle Project directed by the Working Party on Innovation and Technology Policy in November 2014. The authors have to thank for the support, discussion and comments received from the colleagues.

Contents

Table of figures and tables

Introduction

This paper discusses the concept of the Knowledge Triangle (KT) and the discourses and policies in OECD countries which are related to this concept. The KT tries to cover the three missions of higher education (HE) institutions: education, research and innovation, and their interrelations. But while the three vertices of the triangle are each on their own subject of manifold discourses (one-dimensional view), the KT also problematizes the interrelations and interdependencies of the vertices, i.e. the edges of the triangle: education-research; research-innovation; innovation-education (two-dimensional view), and the more complex three-dimensional view of simultaneous systemic interactions of the vertices (networking, or ecosystem approaches).

Basically the knowledge triangle is a quite recent normative policy device, or 'policy ideal' that has not reached the academic research level so far.[1] A literature search in one of the big search machines (EBSCOHOST) gives only eleven pieces of literature (mostly articles, or papers) that mention the expression of the knowledge triangle in the title (six hits) or in the abstract (5 hits). These results indicate that the concept of the KT is processed in a rather small specialist community of policy experts, and the topic addressed by this concept is still tackled at the level of the one- and two-dimensional views.

This provides a mixed starting point with respect to the policy challenges involved. On the one hand, it is a fresh perspective that allows for new approaches to old problems; on the other hand this perspective cannot be based on research evidence so far, and is confronted in terms of a policy development or implementation with the problems and contradictions in the Status-quo of practices and policies. A *main challenge* must be seen in the point that the fresh perspective lies in a radical change of the direction of looking at the relationship between the three vertices from differentiation to integration. This turn concerns strongly the higher education systems and institutions, and their relationships to policy and politics. A main perspective on the development of higher education during the last decades has been one of differentiation for coping with expansion and massification on the one hand, and with the increasing emphasis on change and innovation in the economy and society on the other.

[1] A literature survey using the different sections of EBSCOHOST still displays very few sources. The raw results of the search give the following hits in the four databases: (i) EconLit title from search all text: 1 hit, search abstract 3 hits; search all text 51 hits; (ii) SocINDEX search title: 1 hit, search abstract: 2 hits, search all text: 42 hits; (iii) Education research complete search title: 2 hits, search abstract: 18 hits, search all text: 172; (iv) ERIC: search title: 2 hits; search abstracts: 11 hits, search all text: 12 hits. The thematic inspection of the search results, and the correction for double counting gives from those four data bases only 6 pieces with the expression knowledge triangle in the title and additional 5 pieces with the expression in the abstract. So there are in sum eleven literature sources available in this big search machine that give the knowledge triangle a central position. The inspection and correction gives an additional number of total 68 literature sources that include the expression of the knowledge triangle in the text, without giving it a more central status. Many of these sources are emphasising the topic only marginally, or are dealing with very specific issues.

i. Along the famous differentiation of 'elite, mass, and universal higher education institutions', various forms of differentiation between teaching and research have been observed, which contradict in various degrees the old ideals of the 'unity of teaching and research' (this kind of differentiation has been found firstly in the US system, and has been subsequently conceptually expanded in higher education research, with the Bologna Structure as a special form of the differentiation)
ii. With the increasing emphasis on the role of research for innovation the famous 'linear model of innovation' has distinguished different kinds knowledge and knowledge creation along the principal path of 'downstreaming' from basic research through applied research towards (industrial) development, which indicates a differentiation of different research functions, followed by the emphasis on transfers, and specialised institutions for this purpose
iii. Another perspective of differentiation has arisen with the advent of the knowledge based economy, with the new emphasis on active roles of higher education in the innovation process. A 'third mission' of services to the economy or society, strongly related to the local environment, has been devised in addition to the former missions of teaching and research, which can also be seen as a kind of functional differentiation in higher education. This issue is already more frequently by academic research.[2]

The concept of the knowledge triangle focuses on the importance of the three-way interrelations between the differentiated elements, and on potential ways of their re-integration. Here we can situate some main policy challenges, as a main path of development in higher education would have to be reversed. This is reinforced by the recent trends in governance of higher education towards increased autonomy of the higher education institutions (HEIs), which means that more indirect policies must be used (instead of past state policies in many systems). Basically we can draw a rough distinction of two layers of polices towards the knowledge triangle, one focusing on the institutional level of HEIs, another on the aggregate (external) level of the interrelations between the vertices of

[2] Search EBSCOHOST, comparison of 'Knowledge Triangle' and 'Third Mission'

	Hits Knowledge Triangle	Hits Third Mission	Hits Triple Helix	Hits Entre-preneurial University	Hits Regional Innovation System	Hits Engaged University
(i) EconLit						
title from all text	1	8	41	28	105	1
search abstract:	3	19	83	121	264	28
search all text:	51	160	336	882	1.454	406
(ii) socIndex						
search title	1	5	28	26	25	6
search abstract	2	32	41	48	72	103
search all text	42	328	223	483	252	939
(iii) education research complete						
search title	2	9	24	59	6	34
search abstract	18	40	52	192	16	342
search all text	172	586	326	1.478	128	2.769

education, research and innovation. The first layer must lead to changes of the structures and activities of the institutions (inputs and processes in order to provide new kinds of results, or the creation of new kinds of HEIs); the second layer would focus more on the interrelations of HEIs with their environment, and thus the external players, structures and activities (here the creation of new institutions, providing communication, cooperation, linkages, brokerage mechanisms, etc. between HEIs and the external players, e.g., business firms, the state, local or regional authorities, civil organisations and the like).

- The *key policy challenges* can be seen at this background in relation to first the limits and potentials of influencing the autonomous HEIs by different kinds of policies; second the question which mix of the two layers can or should be used; which in turn is influenced by the performance of the HEIs at the levels of the one-way and two-way-interrelationships between the vertices of the knowledge triangle. To make this approach more concrete, we can provide some examples at these different kinds of challenges: Influencing the autonomous HEIs could mean to address the performance at the three vertices of the KT, through assessment of each, and of the balance, and in case of satisfactory or unsatisfactory performance to provide positive and/or negative incentives or sanctions (depending on the leeway of the regulations, e.g. providing additional resources, or setting conditional mechanisms through performance contracts. A key question concerns the balance between the three vertices, e.g., to which degree the performance on one mission influences (positively or negatively the others); this is a heated debate, and also a question concerning what the available evidence can tell. Examples of policies are the setting of goals/standards for the missions; the structuring of higher education towards different kinds of institutions, assessment and evaluation, governance and financing structures. More concretely concerning the knowledge triangle a key point will be, to which degree the contribution to innovation is given and sanctioned as a principal mission of HEIs.
- The extent to which the two layers of directly influencing HEIs or setting policies at a more aggregate level can and should be selected as areas for policy intervention depends firstly on the regulatory conditions (e.g. the degree of autonomy of HEIs, or the regulations concerning political responsibilities for higher education at different state levels), and secondly on the realistic expectations about the impact of the different activities or instruments. A concrete question at this level concerns the emphasis that should be laid to this kind of external policy instruments, e.g., institutions and regulations concerning the Intellectual Property Rights (IPR), organisations/institutions for knowledge transfer (e.g., Extension Offices), requirements or regulations concerning third-party funds (e.g. matched basic funds), instruments/regulations concerning the interrelation of studying and working (internships, teaching by practicians from outside higher education, employment regulations for graduates, etc.), conditions and/or support for start-ups (e.g., business parks, venture capital). A key question here concerns the expected impact of these kinds of external policies in relation to the direct policies towards HEIs; here

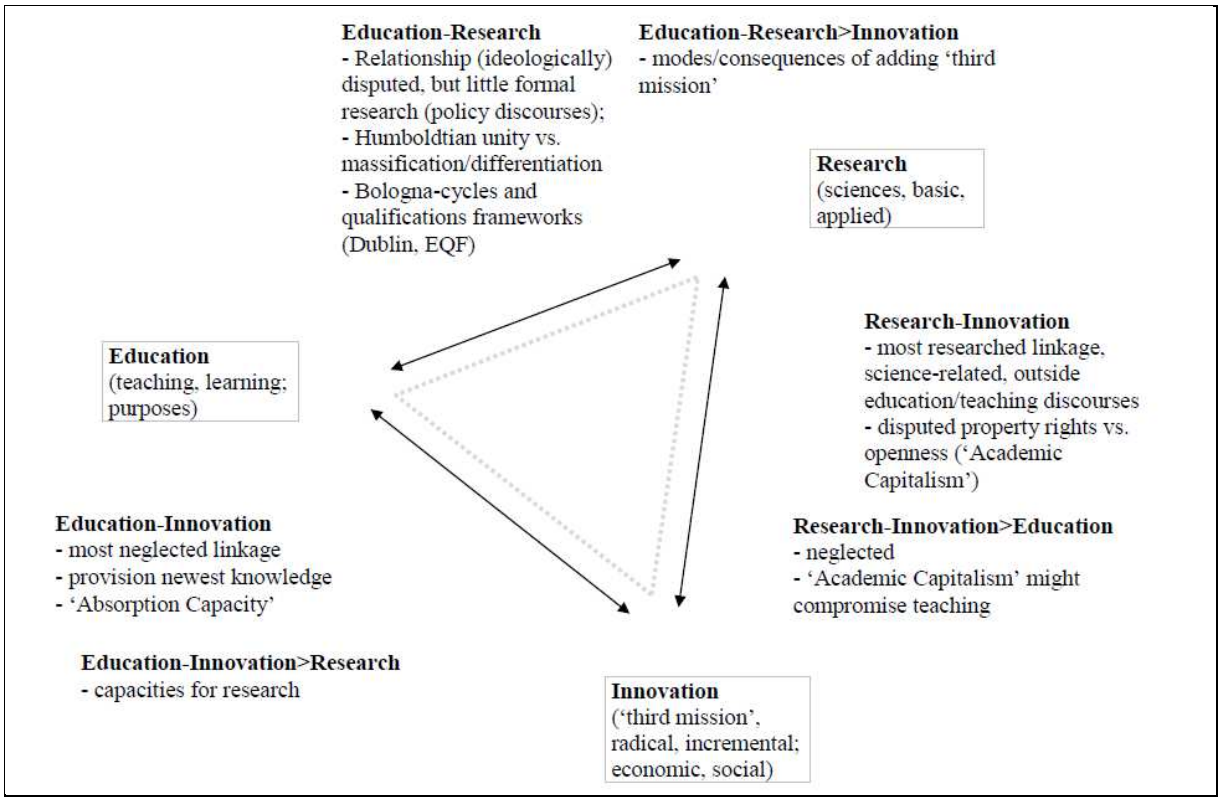
evidence from research might help. The external policy layer also directly includes the external actors into the policy, and requires a balancing of the interests between them and the internal ones. The concepts of the different kinds of innovations systems (national, regional, or local), and competing to them the triple helix of university-industry-government relations (more recently extended to the quadruple and quintuple helix) have developed different views of how the various actors might be tied together in social and organisational structures with HEIs and other research organisations.

- At the third level of the interrelation between given structures/policies at the vertices and edges of the KT and the policies for the strengthening of the knowledge triangle the most complex questions and issues are arising. Here the huge diversity of the higher education sector in different regions and countries is setting the concrete conditions for policies. To which extent can we find generalizable ('one size fits all') policies across these diverse spaces, or to which extent might similar policies work, or find acceptance, differently in different environments? At this level of analysis we propose a kind of hierarchical approach, starting from the performance of the three missions, and what we know about it, through the two-way interrelations of education and research, research and innovation, and education and innovation, to the three-way interrelation at the top. From the review of research we see here various quite big controversies about how the performance of the different missions can be influenced, and about how certain structures or devices of the two-way interrelations between the vertices might influence the performance of them. These controversies include often a mixture of normative and empirical concerns and they often cannot be resolved by available evidence because it is lacking, or gives mixed signals. This proposal for a hierarchical conceptual perspective should point to a danger which we see involved in the concept of the new perspective of the knowledge triangle, namely, that this fresh and persuasive three-way perspective might somehow seduce to forget, or repress what we know already about the two-way relationships. In particular we should consider the involved relation between differentiation and integration in these two-way relationships. A more concrete example is the relation between research and teaching, which includes trade-offs and synergies, which are very difficult to disentangle (even the degree to which the two are interrelated at a given moment is difficult to assess); if innovation should be (massively) strengthened, the immediate question arises, how it might influence the other missions and their interrelations.

A wide range of conceptual terms has been developed in the last decades to describe the changing roles of the old "alma mater" in a rapidly changing society and economy. To some part these concepts and the related discourses can be understood as variations on aspects or configurations of the KT: to some extent they tend to leave one of the vertices (innovation) out of the triangle an consider it as a part of the (external) economic environment; others are emphasising the education-research edge of the triangle and tend to preserve (or call for) the traditional Humboldtian ideal of the "unity of research and teaching" in HE vis-à-vis the

changes experienced and the reform proposals brought forward at the policy level, like the Bologna Reform in the European Higher Education Area, or the various processes of massification and differentiation. .Figure 1 outlines through some keywords the main topics and discourses in the knowledge triangle which we will touch during the report.

Figure 1: Mapping of main topics and discourses in the knowledge triangle



Source: own diagram

Explanation:
'Absorption Capacity' refers to 'the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends' (Cohen/Levinthal 1990); for this purpose the firm must employ the adequate competences.
The literature about Academic Capitalism has early shown, that contrary to widely held expectations the commercialisation of research did not compromise research, but rather teaching (Rhoades/Slaughter 2004)

The first chapter discusses some of the basic definitions which we use throughout this report: the knowledge triangle, and innovation as one of the vertices in the KT, which we see also as the emerging third mission of higher education. In the second chapter we provide the analytical framework that is used for the analysis of policies towards the knowledge triangle at the national and institutional levels in chapter 3. This finally results in the identification of gaps, potential areas for follow-up work and policy questions as requested, including proposals for case studies and a rough outline of new indicators.

1. Conceptual considerations and definitions

1.1 The concept of the Knowledge Triangle

The term “Knowledge Triangle” (KT) is used in several different notions. These definitions differ in terms of the denomination of the vertices and the objective of the KT.

The first and most obvious differences are the names of the vertices. While most *scientific* papers deal with the KT as the interaction of Education, Research and Innovation, *political* papers or concepts often use other vertices. E.g., the European Association of Institutions in Higher Education (EURASHE) draws a KT with the vertices “education-innovation-employability”; the European Institute of Innovation & Technology (EIT) uses “education-research-business” to draw the KT. Other notions use “education, research and knowledge transfer” (UIIN 2014), “knowledge, research and innovation” (Välimaa/Hofmann 2008:265), teaching, research and engagement (Hazelkorn 2010) or assign an “economic development mandate” (Rothaermel et al. 2007:692) to universities as their additional mission for fulfilling their role in the knowledge society.

Two concepts of the KT, which carry much political significance, and represent two very different approaches not only about the KT but also about HE as a field, are discussed in more detail in the following paragraph: the EURASHE and the EIT concepts. EURASHE is the European body of vocational tertiary education institutions (e.g. polytechnics, universities of applied sciences). Vocational education on post-secondary level is organised in various ways across Europe, dealing with the diverse national (and regional) traditions of education, different national economic situations (and histories) and, as a result, very different make-ups of the vocational tertiary education sectors, and the distribution of vocational education and training across the secondary, the post-secondary and the tertiary cycles. The EIT is conceived as a kind of “ideal” European HEI, designed as a strong and world competitive HEI to meet the challenges of the KT in a knowledge economy. Both, EIT and EURASHE refer to the ECs notion of the KT, which actually uses education, research and innovation (e.g. European Commission 2010:12) as the vertices of the KT.

The European Institute of Innovation & Technology (EIT)

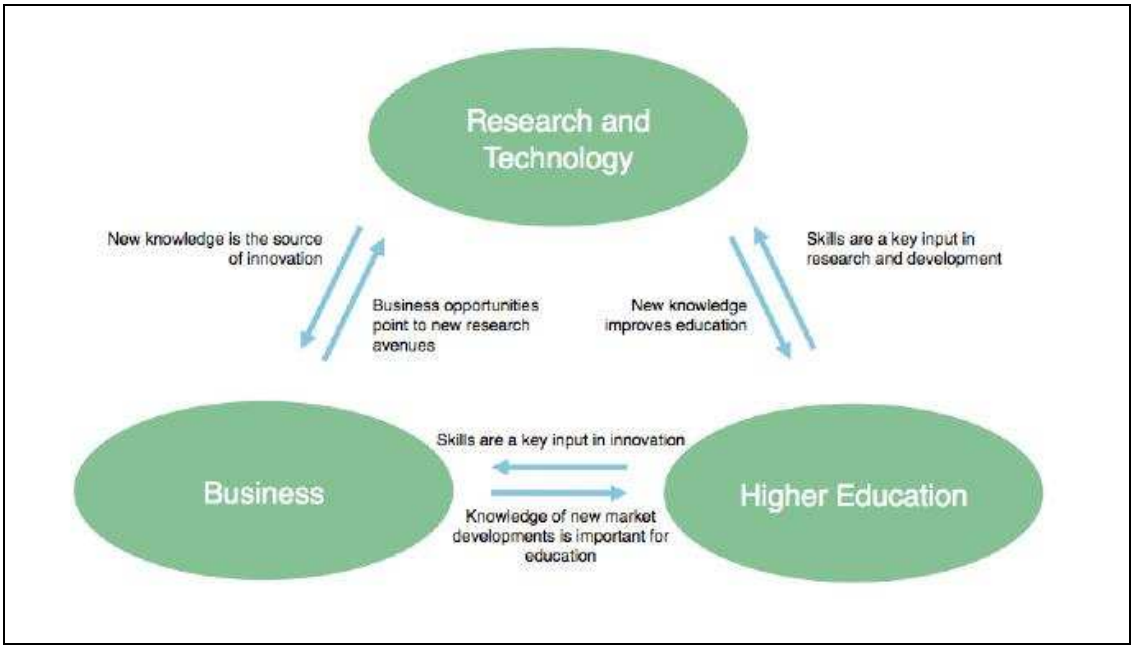
The KT approach of the European Institute of Innovation & Technology (EIT) is based on the EU science program “Horizon 2020” (the successor of Framework Program 7):

> *“The EIT was established in March 2008 as a body of the European Union and its mission is* ***“to increase European sustainable growth and competitiveness by reinforcing the innovation capacity of the EU”.*** *[…] The EIT can also be regarded as a model of innovation governance and*

> *financing in the European Union. It has been given an important role as part of Horizon 2020, the framework programme for research and innovation for the period 2014-2020, with* ***the objectives of addressing societal challenges and assisting the EU to gain leadership in enabling and industrial technologies****. (EIT 2012:2; bold in original)*

This aim is tackled by the collaboration with leading companies such as Deutsche Telekom Laboratories, SAP, Siemens, Philips, Nokia, Alcatel-Lucent, France Telecom, Ericsson, Engineering or Telecom Italia.[3] The list of core and affiliate partners from the industry and business includes mainly ICT companies as well as transport and defence firms, which indicates, that a rather narrow concept of innovation geared towards certain sectors of industry is deployed.

Figure 2: Knowledge Triangle EIT



Source: EIT 2012:5

The EIT launched three *Knowledge and Innovation Communities (KICs)* in 2010, dealing with climate change mitigation and adaptation, ICT and sustainable energy. These KICs are operating in 19 "co-location centres" across Europe. In each of these centres, actors of each vertex of their KT, i.e. "leading players" from higher education, research and business, cooperate: "KICs carry out a whole range of activities, covering the entire innovation chain – including training and education programmes, reinforcing the journey from research to the market, innovation projects and business incubators."[4] The assets of the KICs are, according to EITs own description, their high degree of integration, addressing education, research and

3 http://www.eitictlabs.eu/about-us/partners-of-eit-ict-labs/

4 http://eit.europa.eu/activities/innovation-communities

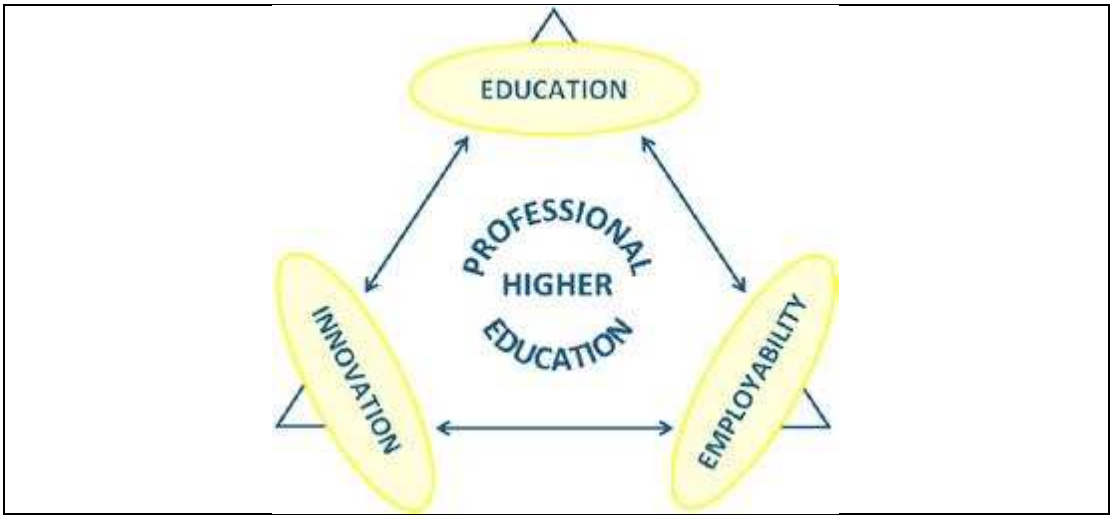
entrepreneurship simultaneously; the long-term perspective for all partners involved, since each KICs has a minimum run-time of seven years; efficient governance in decision making an planning; the co-location model, which also enables the KICs to respond to regional needs or challenges; and the KICs culture, meaning "integrating education and entrepreneurship with research and innovation and operating according to business logic and a results-oriented approach".[5]

The EURASHE (European Association of Institutions in Higher Education) concept

In contrast, the May 2013 EURASHE annual conference about "Higher Education – Making The Knowledge Triangle Work" has presented its KT by the vertices of education, innovation and employability, leaving out research as one of the vertices, and stating:

> *"Europe's ageing population, high unemployment, particularly amongst young people, and strong competitive pressures from globalisation require Europe to stimulate economic growth through innovation in products and services. This is why innovation has been placed at the heart of the Europe 2020 strategy for growth and jobs. The link between education, employment and innovation has long been proposed and has assumed a strongly favoured policy position throughout the world." (EURASHE 2013a:8)*

Figure 3: Knowledge Triangle by EURASHE



Source: EURASHE 2013a:8

The views expressed in the key notes on the KT and innovation aimed at the public acceptance of innovation pointing at the weak engagement of the public in science ("9% actively participate in any public debate or event on science" EURASHE 2013b:11) and the diminishing trust of the public in science and technology to improve living conditions (ibid.).

[5] http://eit.europa.eu/activities/innovation-communities/what-makes-kic-kic

At the same time optimism in the democratisation of innovation (keyword: open innovation) and the communication via new media like the web 2.0 was expressed (e.g., speech by Vladimír Šucha).[6] The conference report, from the point of view of the smaller vocational HEIs, explicitly mentions the differences of this approach to the above mentioned EU science program, "which is widely perceived to be focused towards 'big' science from global brand higher education institutions (HEIs) and large companies" (EURASHE 2013a:9).

1.1.1 A variety of understandings and arguments

Both versions of KTs refer to the same original concept of the interaction of education, research and innovation, and underline different aspects of the concept, on the one hand as a concept for understanding and describing a knowledge intensive ecosystem, which calls for the close and frictionless cooperation of different actors (or the integration of them, like in the EIT concept), and on the other hand as a concept pointing to the broader mission of HEIs, like the EURASHE approach to educate in order to raise acceptance of innovation.

Thus, the different drawings of the KT point at different understandings of the objectives of the KT and of the relationship of the KT and HEIs. The two examples of differently denominated vertices already suggested that definitions of and discourses about the KT assign different objectives to the KT. Although they share a non-linear understanding of innovation processes, the perceptions of knowledge production and the innovation concepts differ. This section looks at different arguments for the need for amelioration of the interaction between the education, research and innovation (or the respective other denominations of the vertices).[7]

The conclusions of the 2009 conference "The Knowledge Triangle Shaping the Future of Europe" provide a definition of the objective or outcome of the KT:

> *"The concept of the knowledge triangle relates to the need for improving the impact of investments in the three activities – education, research and innovation by systemic and continuous interaction. Higher education institutions must be given a central role in building a Europe where the impact of knowledge building can be measured in terms of social and economic progress." (HSV 2009:7)*

This posture combines the function of the KT and the missions of HEIs quite directly and links both to societal and economic advancement. In this perception, HEIs are central for the

[6] Deputy Director General of the European Commission's Joint Research Centre (JRC).

[7] However, most of these papers refer to European or US-American policies. This results of the fact, that e.g. in Japan "there is no concept of the "knowledge triangle" employed" (Woolgar 2013:23). This does by no means mean there would be no policies on innovation, research and education. It seems rather to be a conceptual turn in western countries to make the interactions between those three themselves the subject of discussion.

advancement of a knowledge society with measurable outputs; the KT itself is understood as the amplifier of investments in each of the three vertices. This perception emphasises the importance of each of vertex. The triangle drawn by EURASHE focuses rather on the joint output, which is better educated graduates, who are not only well educated workforce but are also adopters of technological as well was social innovations. The EIT again deploys a more narrow approach, when putting the joint investment of business, research and (higher) education for the developments of new technologies at the heart of their KT.

This overview illustrates the variety of policies and discourses on (higher) education, research and innovation, which refer to different perceptions of the mission of HEIs in the triangle. For the purpose of this paper, the KT is understood as inherent relationship of the activities of HEIs, which are education, research and, as a third mission, innovation.

1.2 Innovation as a 'third Mission' of HE institutions

1.2.1 The evolution of the third mission of higher education institutions

This section gives a short historical insight into the development of functions of higher education institutions with a particular focus on innovation as a third mission of HE institutions. The main point is that the historical development of higher education is basically characterised by a stepwise accumulation of main missions (teaching, research, innovation), and later by the quantitative expansion or massification, and that HE reacted to this emergent process by differentiation, which takes various forms. The idea of the KT reverses this long term process of differentiation.

The claim of a third mission, or a threefold function of HE institutions or especially universities, is bound to developments of societies and economies. Going back to the origins of universities, the first focus of HE institutions was education only, mainly in Theology, Law and Medicine. In Europe research developed historically mainly outside the traditional universities. In Germany as a special case the Humboldtian university was based on the ideal of the unity of education and research ("Einheit von Lehre und Forschung"). This model is seen as the paradigm for the "first academic revolution" through the export of the concept of unified teaching and research to the United States.[8] Thus, universities as institutional producers of knowledge are actually a rather "new" concept in history.[9] And most of the time,

[8] "Johns Hopkins University, founded in 1876, was the first American university to be established from the outset as a research university; during its first two decades, it produced more Ph.D. degrees than Harvard and Yale combined. Johns Hopkins was followed by Clark University (1889), Stanford University (1891) and the University of Chicago (1892). By the turn of the century, several state universities had established their credentials as leading research institutions, including the universities of California, Michigan, Wisconsin, Minnesota and Illinois." (Atkinson/Blanpied 2007:5)

[9] This might be important with respect to the historical development of higher education systems and the conditions for change and reform, as in some countries (e.g. Austria or Germany) the higher education system consists of mainly a set of very old universities, whereas in others (e.g. Finland) the higher education

also industrial development was not (and to many observers still is not) mainly driven by scientific research. It was just after World War II, that scientific-technical development became a driving force for knowledge production within the universities. Before that, their contribution to innovation was mainly the education of technical professionals (by now the edge of education and innovation in the KT).

In higher education research the differentiation hypothesis was mainly based on the structure of the US-American higher education system, where the massification of HE started earlier than in other countries. The differentiation of functions went along with the differentiation between and within HE institutions, with the research universities taking the lead in the system, and combining the different functions more than the other types.[10] The emergence of the leading role of research (the graduate schools at research universities) in US higher education in the 1960s was termed the 'second academic revolution' by Jencks/Riesman (1968) Etzkowitz (2004) has found the "second academic revolution" already laid out in the "Land-Grant-Universities" in the late 19th century.[11].

From the European perspective, it seems like a paradox, that the attempt of unifying education and research in the sector of research universities fostered the institutional differentiation of the overall higher education system. This was rejected in Europe for a long time (and to a certain extent at least ideologically still is strongly rejected).[12] The Bologna reform and the Dublin framework have taken clear steps towards differentiation with the first two cycles mainly allocated to teaching, and then confining to the third cycle the kind of

---

system consists of mainly rather new reform universities from the onset of the massification period in the 1960s; we might expect that reforms will be easier in the second regime.

[10] According to Parsons/Platt (1973) 'The American University' fulfilled four functions in a differentiated way and to a large part in differentiating institutional settings (although belonging to one university): general education in undergraduate schools, professional education at professional schools/colleges, research at graduate schools, and societal engagement by producing intellectuals.

[11] "The first quasi-research universities in the United States were the land grant colleges created by the Morrill Act of 1862, whereby lands belonging to the US government were transferred to the states on condition that proceeds from their sale of land was to be used to establish colleges (and later universities) to teach practical science, primarily in agriculture and the mechanical sciences. Faculty members at these institutions were also expected to conduct research in their areas of specialty (primarily in agriculture) and to create outreach programs to disseminate the results of their investigations to farmers in their respective states." (Atkinson/Blanpied 2007:4)

[12] "Trow (1970, 1974) interpreted diversity in functional sectors, not institutional sectors: elite, mass, and universal higher education. In looking at the European scene, Trow (1979) later pointed out that politics in Europe did not accept the logic of expansion and diversification, but counteracted deliberately and in a targeted manner that – according to his view – was functionally detrimental. […] The popularity of this two-type model was primarily clearly based on the assumption that expansion of higher education could be accommodated with moderate changes for the universities through the establishment of another sector with different curricular thrusts, an intake of new student groups and lower unit costs per student and graduate. This might be viewed as the European interpretation of Trow's distinction between "elite" and "mass" higher education. It implied that the key carrier of a "mission" – in order to employ the currently popular religious jargon – is the institutional type and not, as in the U.S., the individual higher education institution." (Teichler 2008:359f)

scientific research that explicitly aims at shifting forward the border of knowledge.[13] The framework states a clear relationship of the provided/acquired competences to the "preparation for the labour market" (p.23), and in combination with the definition of research the cycles (p.66-69) state among other dimensions different kinds of activities: cycle 1 gather and interpret data to inform judgement including reflection; cycle 2 includes additional keywords as complexity, incomplete information, responsibility; cycle 3 original research that extends the frontier of knowledge. Accordingly, the set up and development of institutionally separate graduate education or doctoral schools are part of the Bologna process. However, the extent to which the third cycle is given the clear leading role in the system (as has been asserted to the US system), is not clear. In terms of implementation of this framework by the HEIs and its use by the students different practices are possible, that concern the career structures. In some countries (e.g., Ireland) the framework constitutes two parallel pathways, professional and academic, whereas the academic programmes open a direct path from the first to the third cycle; in other countries each cycle must be taken, and there is a strong pressure to go directly from the first to the second cycle to preclude even the temporary production of Bachelors.

The expansion of higher education became a global process, in particular from the 1960s (Schofer/Meyer2005). In Latin America (Arocena/Sutz 2005) the expansion of HE began in the early 20th century, and was related to a kind of popular movement 'Movimiento de la Reforma Universitaria', distant to government and industry, which lasted into the 1970s, and was renewed during the 1980s. In the 1980s the situation changed, and became much more heterogeneous. From the 1960s a strong expansion started with an increasing proportion of private enrolment, and most systems evolved from elite to mass HE until the 1990s. For some period the demand for academic labour was not high, and the quality of parts of the sector was also criticised. In the 1990s the trend towards the entrepreneurial university also reached to some degree Latin America, however, there were also still big inequalities.

HE in Asia has a very high international component (Altbach/Reisberg/Rumbley 2009), and because of the high population figures the systems are very huge in absolute terms. The expansion started later, in the 1990s in India (Pilkington/Nair 2013), where still a two-tiered elite system prevails (10% participation). China is also expanding quickly since around 2000 and has strong plans to further expand. A set of world-class universities is built up since 1998 (HSV 2006:23-24). Internationalisation is deliberately very high, with other countries providing services in Asian countries, and many young people also study abroad. In this way the quality of the quickly growing systems should be improved.

[13] The definition of research is as follows: "The word 'research' is used to cover a wide variety of activities, with the context often related to a field of study; the term is used here to represent a careful study or investigation based on a systematic understanding and critical awareness of knowledge. The word is used in an inclusive way to accommodate the range of activities that support original and innovative work in the whole range of academic, professional and technological fields, including the humanities, and traditional, performing, and other creative arts. It is not used in any limited or restricted sense, or relating solely to a traditional 'scientific method'. (Bologna Working Group 2005:68)

Since the 1980s, when innovation research about the sources of economic growth and the (industrial) enterprise sector became a hot topic, the attention shifted to the direct transfer of knowledge from universities to society and/or economy. A 'third academic revolution' related to the concept of the entrepreneurial university that should directly contribute to innovation has been devised by Etzkowitz/Viale (2010). Another expression of these direct contributions of universities to innovation has been to add a 'third mission' of the university to the traditional missions of teaching and research.

A review of the literature on the "third mission" makes quite clear, that there is no such thing as a finite specification of the term. But there is a consensus in the meaning of the third mission as being understood as an outreach to the surrounding environment. Still, for the evolution of the third mission of innovation becoming the third vertex of the knowledge triangle, the process of institutionalisation of this mission becomes crucial.

HE institutions experienced a gain of regional (e.g. Stanford and Massachusetts) importance and increased their contributions to usable knowledge and industry accompanying the rise of information and communication technologies (see also the sections on regional innovation systems (p.19) and the "entrepreneurial university" (p.16)). However, those approaches do not perceive innovation as endogenous development processes of HE institutions, but rather as a reaction of universities to their changing environment. However, the contribution of HE to economic innovation has often been treated only peripherally in higher education research, while at the same time innovation research merely has dealt explicitly with universities (taking their inputs implicitly for granted). The social innovative character of universities has was also been stressed by more recent national and international policy considerations (see the sections on "Mode 2 knowledge production" (p.21) and the "engaged university" (p.22).

The third mission of universities or HEIs must be seen in relation to the existing forms of differentiation, on the one hand to the differentiation according to the elite, mass, universal HE divide, and on the other hand to the longstanding of differentiation of research according to the linear model by basic and applied research and development. This linear model has been criticised for a long time by different approaches, and has been conceptually replaced by more fluid concepts, however, at the level of policy practices and institutional differentiations it is still very familiar to use these traditional distinctions (e.g., basic and applied research, and the respective providers). Based on these various kinds of differentiations, the question arises to which degree the third mission should concern the highly valued research universities being the academic core institutions of the HE systems with their core task of basic research, or to which degree the third mission should be mainly provided by the lower rank institutions assigned to teaching and applied research and development. To some extent there seem different understandings of the third mission in different institutional contexts. Etzkowitz/Leydesdorff (2000:109-110) have pointed to the example that "the Swedish *Research 2000* Report recommended the withdrawal of the

universities from the envisaged 'third mission' of direct contributions to industry […]. Instead, the university should return to research and teaching tasks, as traditionally conceptualized." However, the debate in the US concerns mainly the core research universities, with the M.I.T as a paradigmatic case.[14]

1.3 Concepts of the "third mission"[15]

Despite the well-known concept of the 'third mission', and some available research (see FN 2), there is so far no agreement in the literature about the concrete ways of involvement of higher education in innovation. The "third mission" is an expression that somehow dazzles between normative and empirical, evaluative meanings. In a recent project (Lassnigg et al. 2012)[16] a variety of different meanings of the "third mission" has been analysed from the point of view of HE research on the one hand, and of regional and innovation research on the other. A basic premise of this analysis was that the performance of the third mission should be related to the local and regional environment of HEIs. This view sees HEIs and particularly research universities as locally situated nodes that provide linkages between a global knowledge space, of which they are a part, and the various local and regional players.

The meaning of the "third mission" was condensed into four major concepts, that overlap to some degree, and can be seen as different facets of the relationship of HEIs to their environment: (1) the entrepreneurial university, (2) regional innovation systems, which are both applying a rather narrow economic notion of innovation, and two concepts with a more holistic-societal approach, (3) the 'Mode 2' transdisciplinary knowledge production and (4) the engaged university or community engagement. The distinction between these possibly overlapping concepts lies in the different strategic and instrumental orientations and identities which follow from these concepts. In principle an entrepreneurial university can act within a regional innovation system, however, we can expect, that it will act differently, depending on which concept it takes. The RIS will overrule the entrepreneurial university. Similarly working in the mode 2 means to develop transdisciplinarity and problem-oriented research, which is also a more pronounced concept than the engaged university. A HEI in a RIS can also work in mode 2, however, this is not necessarily so. Thus we can take these forms, which are to some extent condensed and known as kinds of orientations how the third mission might be implemented or enacted. An advantage of this classification can be seen in its extension of the third mission from the dominating concept of the entrepreneurial university to broader concepts that include important aspect which would otherwise

[14] See as an example the Production in the Innovation Economy Project: http://web.mit.edu/pie/america/index.html

[15] This section draws heavily on the contributions by Michaela Trippl, Tanja Sinozic, and Alexander Auer to Lassnigg et al. 2012.

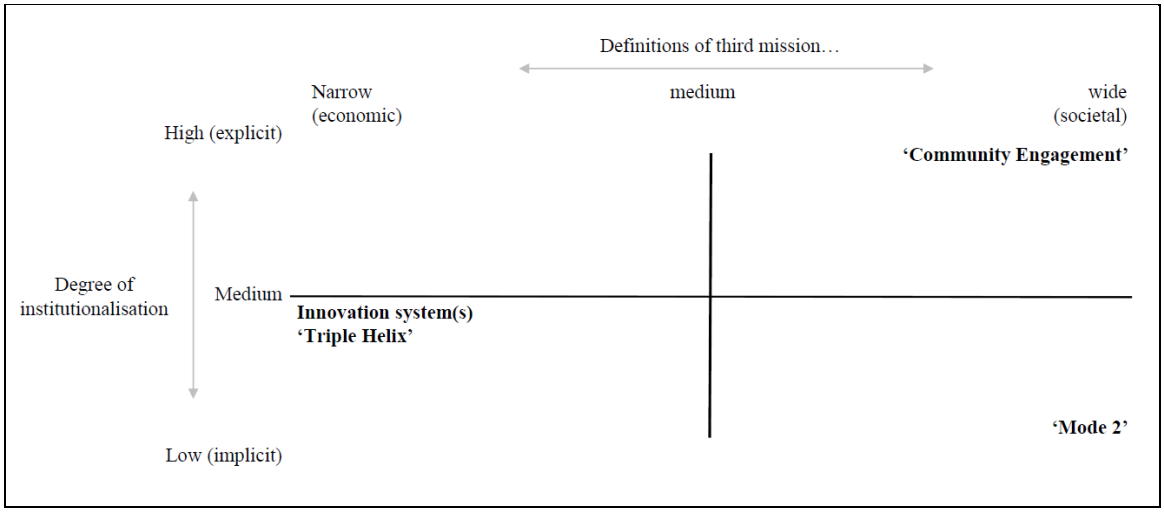
[16] Lorenz Lassnigg, Michaela Trippl, Tanja Sinozic, Alexander Auer (2012) Wien und die „Third Mission" der Hochschulen [Vienna and the "third mission" of higher education]. Studie im Auftrag der MA 23 - Wirtschaft, Arbeit und Statistik, Stadt Wien. IHS research report in cooperation with the Vienna University of Economics and Business (WU) (November).

neglected. So these concepts also can create some diversity of how the third mission can be performed. Maybe we can put them in an analogy to the various teaching-learning methods or the various research strategies at the other two missions.

This classification materialises a range of gradually intensifying roles of HE institutions in the innovation activities based on Uyarra (2010), ranging between the traditional view of "fabrication" of knowledge and providing it without direct involvement of HE in innovation, and the encompassing "engagement" of HEIs in various forms of innovation. If we add the degree of explicit institutionalisation of the "third mission" as a second dimension, we reach a classification shown in figure 4.

The concepts (1) and (2) of the entrepreneurial university and the regional innovation system see innovation and the "third mission" in a narrowly focused technological and economic sense. This perspective does not consider the broader societal contributions of higher education (Doberneck et al. 2010, Glass et al. 2011). Various authors plead for a broader perspective on the third mission (Chatterton/Goddard 2000, Glasson 2003, Smith 2003, Breznitz/Feldman 2012a, Breznitz/Feldman 2012b) that has been taken by the concepts (3) and (4) of the Mode 2 and the engaged university.

Figure 4: Dimensions of the "third mission" (width and degree of institutionalisation)



Source: Translated from Lassnigg et al. 2012

However, these four predominant concepts are seldom encountered in their "ideal typus" form, i.e. HEIs may undertake efforts toward meeting the third mission with mixed approaches. E.g., HEIs may implement New-Public-Management and do at the same time seek for stronger engagement with their regional ecosystem. Nonetheless, these concepts can serve as analytical concepts for the assessment of policies and their implications.

We try to give a balanced picture of these models based on empirical literature. For each model we give the basic shape, some empirical findings, and some main points of critique, which show that none of them is 'perfect'.

1.3.1 The "entrepreneurial university"

The concept of the "entrepreneurial university" is closely linked to the work of Henry Etzkowitz and his colleagues (Etzkowitz et al. 2000, Etzkowitz/Leydesdorff 2000, Etzkowitz 2004). The authors observed a growing interdependence between the institutional spheres of the economy, the state (politics), and higher education institutions, and subsumed the arising interdependencies under the image of a "triple helix". Burton Clark (1998, 2001) has originally developed and codified the concept of the "entrepreneurial university" by five main design factors (financing, steering, external networks, academic values, entrepreneurship); however, this complex image has been rather reduced in the subsequent (political) discourses to the image of a market enterprise.

In detail, different versions of the entrepreneurial university exist (Baumeler 2009). One family of approaches, including Clark's work, is focusing on the managerial dimension; other approaches are focusing rather on the external relationships of HE institutions, and the aspects of capitalisation and economic use of knowledge.

Clark's approach is based on the analysis of cases of HE institutions that were closely involved in innovation activities. The entrepreneurial university is seen as a combination of the following factors that find certain configurations in this model:

(1) *Diversified financing*, based on the generation of additional funding from private sources through the activities of the universities on top of the (state) general funds for education and (basic) research. Concerning the third mission ideas of 'Third stream' funding have been proposed as a kind of basic funding for the development of this mission. In the U.K. we can find additional funds under this title.

(2) *Steering and management*. A second element is the combination of the academic collegiality with additional management procedures, and thus the development of governance structures using elements of 'New Public Management'.

(3) Activities of *external networking* and boundary spanning are called the "*developmental periphery*" of the entrepreneurial university. This element denotes the direct involvement in innovation activities, and includes many forms of institutionalisation, e.g., personal transfer for education or research purposes, knowledge transfer institutions (TTOs etc.), science parks or innovation centres, partnerships with enterprises, or spin-offs.

(4) *Academic values*. An often neglected element of this view of the entrepreneurial university is the complex concept of the "*academic heartland"*, which denotes the core academic field in a HE institution that should be still the main area of development. This element can be seen as the most contested area in the critical discourses about the "third mission" and the entrepreneurial university.[17]

(5) *Entrepreneurship*. Here Clark focuses on the aspect of an "entrepreneurial culture" including new orientations of all involved actors, and in particular the active initiative, motivation and engagement of the university and the academic community. The HE institutions are in this view not objects of external forces, but able to shape their own position and strategy: this factor explicitly includes the use of incentives and fighting bureaucratic obstacles to entrepreneurial practices.

A more recent empirical analysis of regional effects of Nordic HE institutions argues that the entrepreneurial university to function needs certain material and contextual ingredients.[18] . In the perspective of Etzkowitz (Etzkowitz et al. 2000, Etzkowitz 2004; see Guerrero/Urbano 2012 for a more recent overview about this research) the university has added a new "mission of economic development" to the older missions of teaching and research. The marketing and capitalising entrepreneurial activities (i.e. patenting, licensing, spin-offs) have two interlinked aims: to contribute to the regional or national economic potential, and to generate revenue for the institution. The additional mission changes the traditional missions, as well as the organisation and steering of the institutions. Goldstein (2010) has summarised a number of more concrete ingredients of the entrepreneurial university from empirical research, focusing very much on the business model, and neglecting the factor of the 'academic heartland':

- New organisational forms of research activities, e.g. strategic alliances with external actors, which are from the beginning oriented to commercialisation and generating revenue

[17] The critics of the new approaches fear that this traditional core area of the complex academic heartland, which is difficult to define, would be compromised by the additional "third mission" and the entrepreneurial and management orientation. Main aspects of this area are "critical thinking" and the "democratic missions" of the academy. Rhoades und Slaughter (2004) mention "republicising" as a counter strategy to "academic capitalism". Olsen (2005) makes a distinction between the university as institution, and the university as an instrument, whereby the traditional functions are settled in the institutional model, whereas the contribution to innovation is settled in the instrumental model of the university.

[18] "The requisite for creating an entrepreneurial university is a critical mass of research with commercial potential. The main factors in creating an entrepreneurial university are internal culture and external environment, especially the industrial environment. It is possible to influence change in both of these factors through initiating measures to encourage entrepreneurship and regional development. Entrepreneurial universities play different roles in various triple-helix constellations, which can be guided to a greater extent by one of the three institutional spheres. In a *university*-pulled triple helix model, entrepreneurial universities take the lead in regional innovation. In a *government*-pulled model, entrepreneurial universities assist the development of existing industries and creation of new industries at the request of government. In an *industry*-pulled model, such universities typically cooperate with industry in product and process innovation." (Lindqvist et al. 2012a:15; emphasis added)

- The commercial use of knowledge becomes an evaluation criterion of the university, with changes in the individual wage and incentive structures
- Educational activities change towards more forms of coaching, and opportunities for external experience of students
- To improve the conditions of cooperation with government and the economy intermediary actors evolve (TTOs, juridical services, etc.)
- Academic spin-offs are arising, as are services to support them
- Economic rationality complements cognitive rationality in internal (students as "customers") as well as in external relations

In sum, this view of the entrepreneurial university points to the tasks and responsibilities of transfer and commercialisation of knowledge, in addition to its production. Main policy implications are the establishment of intellectual property rights (IPRs), and the support of instruments and organisations for the support of knowledge and technology transfer, and for the improvement of the interaction of universities and industry.

Starting with Clark's examples, the universities of Warwick (England), Twente (the Netherlands), Strathclyde (Scotland), Chalmers (Sweden) and Joensuu (Finland), the entrepreneurial university has become a dominating label for contemporary university reforms since the 2000s (e.g. in Austria or Finland), that have given substantial autonomy to the HEIs, and also require the acquisition of additional funds for their operation.

Critique, or barriers of the concept

- Some authors see little "micro-foundation", and point to a low disposition of academics for the commercialisation of knowledge (Goldstein 2010, Perkmann et al. 2011); however, these studies show also an openness of scientists towards more soft forms of cooperation with the enterprise sector (research cooperation and contract research, informal exchange of knowledge, etc.)
- There is also evidence that financial incentives are often not the main motives of researchers (D'Este/Perkmann 2011, Lam 2011); co-operations with enterprises are often motivated by their positive effects for academic research (e.g., new ideas for future research, or practical testing of academic knowledge)
- The revenues from the property rights are often behind the expectations, many universities could not generate significant income from this kind of activities (Geuna/Nesta 2006, Weingart 2010, Breznitz/Feldman 2012b)
- Finally, the proposition by Etzkowitz et al. (2000), that the entrepreneurial university would be a global phenomenon with an isomorphic path of development has been heavily criticised (e.g., Philpott et al. 2011).

1.3.2 Regional innovation systems

The innovation system approach sees a high degree of division of labour and of non-linear exchange of knowledge among the various actors (enterprises, HE institutions, public institutions, etc.) as a main characteristic of innovation processes (e.g., Lundvall 1992). Regional innovation is a kind of collective learning which results from the interplay of the various actors in a regional innovation system (RIS; see Asheim/Gertler 2005). Compared to the entrepreneurial university this approach puts much more emphasis on a balanced view of the various actors involved in innovation (the developmental periphery in terms of B.Clark). A RIS is composed of three subsystems, including the respective actors:

- *Generation and diffusion of knowledge*, composed of the regional institutions of research and teaching, as well as technology transfer and human resource development
- *Application and (economic) utilisation of knowledge*, includes the regional enterprises
- *Regional political and policy system and its supporting/promotion institutions*

Those subsystems are seen as embedded in a common regional socioeconomic and cultural context, and ideally interact in an intense net of flows of knowledge, human capital and resources. Small and medium enterprises SMEs are explicitly conceived as participants in the knowledge exchange with the economy (see Uyarra 2010). The RIS-approach does not exclusively focus on the direct commercialisation of knowledge from higher education, but includes a much broader set of exchange mechanisms, e.g. consulting or commissioned research, as well as formal co-operations, networks or industry clusters. In particular this approach also includes all knowledge exchange mechanisms that are not directly financially compensated, e.g., informal contacts or “knowledge spill-overs” (Tödtling et al. 2006, Trippl et al. 2009).

HE institutions are only one player in a complex set, and their effects depend on many aspects of the configuration of the RIS, e.g., the structure of relationships and the potential of the various players. Different kinds of regions – metropolitan, or more remote rural or old industry regions – provide different contexts, and the role of HE institutions might be substantially different (Tödtling/Trippl 2005).

Main results of empirical research in this approach are:

- The transfer and exchange of knowledge, which is not only dependent on the HE institutions, but depends on the contributions by the various actors and their interactions is a very important element in innovation.
- The demand for knowledge, and the potential of the regional economy to utilise the supply of knowledge (“absorption capacity”) are of equal importance as the sufficient

supply. The demand for knowledge depends on the regional economic structure; various trades and sectors differ significantly by their knowledge base (Asheim/Gertler 2005), or their learning and innovation practices (Jensen et al. 2007).

- In traditional sectors that use a *synthetic knowledge base* innovations are driven by the "Doing-Using-Interacting (DUI)"-type of learning and innovation; experience, informal learning, application and recombination of existing knowledge, and cooperation with customers and suppliers are main sources of innovation.
- The (high-tech) sectors using an *analytic knowledge base* apply the "Science-Technology-Innovation (STI)"-type of learning and use innovation that is built on the scientific and technological knowledge as well as on interactions with universities and other research organisations.
- Thus, different sectors demand different kinds of knowledge. However, recent research shows that the sectors working in the DUI-type also make increasingly use of scientific research and strengthen their absorption capacities (Robertson/Smith 2008); innovative enterprises in these sectors might combine the DUI and STI-types and cooperate intensely with regional universities to generate new products and process technology (Trippl 2011).

The RIS approach emphasises the context dependency and situation specificity of the knowledge transfer and use (Tödtling/Trippl 2005), and points to the different types of learning and innovation (DUI and STI) which need different kinds of knowledge bases, and development, transfer, and circulation mechanisms. Thus a broader set of activities of knowledge exchange (mobility of workers, research cooperation, informal and non-commercial mechanisms) is considered, which do not so much privilege HE institutions as suppliers. Political consequences are beneath the strengthening of the role of HE institutions in the regional innovation activities also to consider the roles and potentials of the other players in the system, and to strengthen the interactions including SMEs and the integration of HE institutions in broader regional structures (e.g., cluster development, and regional steering bodies; "Multi-Actor-Governance").

As an approach for the third mission of higher education the involvement of HEIs in the regional interactions and processes is the most important aspect, and besides HE the role of vocational education is an important asset in DUI Innovation. An actual literature search about new examples of regional innovation points much to developments in China (Zhao et al. 2013; Zhao/Richards 2012). The OECD (2008) special issue gives a good overview over the roles of universities in regional development, and the literature search also provides mainly studies from this period. The analyses by the group of Lester (2007) or the research by Audretsch/Phillips (2011) about local systems, combined with entrepreneurship can be taken as examples. A substantial further development and refinement of the RIS can be seen in the use of smart specialisation in the regional context. This approach tries to concentrate

resources in areas where demand can be reasonably identified (OECD 2013c); however, the concept of the KT is not mentioned in this context.

Critique, or barriers of the concept

- A main point of critique refers to the relationship between regional and wider processes beyond the regional context, and to a neglect of the creation and circulation of knowledge beyond the regional borders.
- New research has shown, that specific combinations of regional and trans-regional knowledge might be particularly supportive for innovation (Bathelt et al. 2004, Trippl et al. 2009), as HE institutions as well as enterprises are embedded not only in regional, but also in wider relationships.
- How much universities in fact specifically contribute to their regional context as compared to wider spaces up to the global one has not much been systematically analysed so far in this approach.

1.3.3 "Mode 2 knowledge production"

The broader approaches about more fundamental changes of the role and structures of science and research in society are not explicitly related to the KT or the "third mission" of HEIs, however, they contribute in their essence substantially to the issues at stake. These approaches point to major transformations of science and research and their institutional bases, as well as to the evolution of new forms of knowledge production and use (see for a discussion Hessels/van Lente 2008). In this family of broader approaches we can identify the "Mode 2 of Knowledge Production" (Gibbons et al. 1994, Nowotny et al. 2001), the "Strategic Research/Strategic Science" approach (Irvine/Martin 1984, Rip 2004), the "Post-Normal Science" (Funtowicz/Ravetz 1993) and the "Post-Academic Science" (Ziman 2000). They commonly observe an emphasis on the production of "relevant" knowledge that includes a strong relationship between higher education actors and the actors in the practical fields external to higher education and increasing amounts of interaction and linkages ("transdisciplinarity").

The most prominent approach is the "Mode 2 Knowledge Production" (Gibbons et al. 1994; Nowotny et al. 2001, 2003). In addition to the traditional disciplinary scientific "mode 1" controlled by the scientific community ("peer review") at universities, a "mode 2" of knowledge production has emerged. This "mode 2" is oriented to application, transdisciplinary, is heterogeneous, reflexive, accountable to forces in the wider society, and exposed to different mechanisms of quality control. Due to this development the universities and the academic institutions have lost their monopoly in (legitimate) knowledge production, which in the "mode 2" is driven by "transdisciplinary" networks of diverse participants, and by the contexts of application. The problems are generated cooperatively by scientists and practitioners and users, and the quality criteria are widened by economic, political, social, and cultural aspects. The questions of dealing with the limits and dangers related to the

traditional self-reflective mode of scientific knowledge production are explicitly integrated into this approach.

The “mode 2” approach is interpretive and oriented to practical solutions; it is very productive as a frame for an extended understanding and interpretation of the phenomena related to the KT and the “third mission”. It can be seen as an approach of the third mission, as it is situated at the interface of higher education and society, emphasising the co-production of knowledge, and stretching as well as dissolving the borders of the traditional scientific institutions. In terms of third mission activities this approach pleads for a stronger and broader societal engagement of higher education. The HE institutions contribute to the production of knowledge applicable to the solving of problems beyond the borders of disciplines (e.g., concerning the environment, health, or social disintegration and conflict); thus the “mode 2” implicitly attributes a “societal mission” to the university and higher education. In political terms the “mode 2” asks for the support of transdisciplinary approaches or programmes or projects that are related to today’s and tomorrows big challenges.

Critique, or barriers of the concept

- It is not completely clear which kinds of knowledge production should be subsumed under the “mode 2”. Sometimes “mode 2” is mixed with kinds of applied research or development, and the identification of practices to be subsumed to this transdisciplinary approach becomes unclear.
- The proposition of the emergence of a new mode with the sketched characteristics is still strongly contested. A main argument is that “mode 2” examples were not representative for the whole range of scientific research, but only for small and specific fields or disciplines of big relevance for politics, e.g., environment, health, energy, climate (Weingart 1997, Hessels/van Lente 2008).
- Another critical argument is that the propositions about new forms of reflexivity and social accountability were not sufficiently analysed and clarified so far (e.g., Hessels/van Lente 2008).

1.3.4 The “engaged university” or “community engagement”

Engagement denotes the strongest and most complex relationship of HE institutions to their environment, and includes social and societal dimensions as well as the technological and economic dimensions. This concept represents an opposite to the entrepreneurial university, by pointing to the potentials of democracy (as contrasted to the potentials of the capitalist economy), and by using knowledge as far as possible as a free and public good (as contrasted to the capitalisation of the IPRs; for an attempt to reconcile academic entrepreneurship and community engagement see Kingma 2011). Historically it came up in the 1990s, and can be interpreted as a reaction to the high times of neoliberal politics. Being still mainly a practical-political movement, community engagement (or similarly civic

engagement) as an approach to the "third mission" has not reached much of the status of a conceptually formalised or codified concept.

In a global context the universities in Latin America, according to a long-term analysis by Arocena/Sutz (2005) can be attributed a historical affinity to this kind of third mission towards the public good. In the contemporary situation the authors see a strong massification and also an increasing diversity between countries. Overall two crisscrossing tensions are mentioned, one between internal and external demands and the other between the societal and the economic demands. Four scenarios of future development are presented, conservativism, dualism, fragmentation, and "a fourth scenario is possible, 'the renovation of the socially committed university'" (Arocena/Sutz 2005: 589).

Searches of the literature find rather examples of individual institutions or networks (that appear not always stable),[19] than formal analysis. In the US, Australia and Canada several activities exist in this approach which are also to some degree reflected in publication organs (e.g., Sandman/Thornton/Jaeger 2009, Hall 2009, Bowen 2010).[20] A global network of universities has evolved on basis of the "Talloires Declaration on the Civic Roles and Social Responsibilities of Higher Education" (2005), including currently 325 Network members in 72 countries around the world.[21] Purposes are voluntary activities, including educational functions towards students, and established community relationships in research. In Australia the HE institutions are politically committed to engage in their communities, including reporting and evaluation (Stella/Baird 2008, Sunderland/Muirhead/Parsons/Holtom 2004).

Newcastle University appears as a "flagship example" in the U.K., which aspires to become a "World-Class Engaged University", and which has also provided much development work, supported by national and European sources (Newcastle University 2009).[22] Another important activity is the international "PASCAL Universities Regional Engagement"-project (PURE), that has grown out of the OECD (2007) Project about "Higher Education and

[19] From the earlier analysis in Lassnigg et al. 2012, some of the examples are already outdated; e.g. the quite impressive Higher Education Community Engagement Model at the Higher Education Community Engagement Hub from 2003 seems rather inactive today, about ten years later, see http://www2.warwick.ac.uk/about/communityold/communityhub/; another example refers to closing experiences of community related institutions, e.g., "Sussex to close Community Engagement programmes." , Grove 2012, http://www.timeshighereducation.co.uk/story.asp?storycode=418817).

[20] See, e.g. The Journal of Community Engagement and Higher Education http://discovery.indstate.edu/jcehe/index.php/joce/issue/archive

[21] See the declaration http://talloiresnetwork.tufts.edu/wp-content/uploads/TalloiresDeclaration2005.pdf; members: http://talloiresnetwork.tufts.edu/who-we-ar/talloires-network-members/

[22] The project was supported by the U.K. research councils (ESRC-Project "Universities Engagement with Socially Excluded Communities"; Regional Impacts of Higher Education Initiative; HE Funding Councils in the U.K.; Research Councils U.K. "Territorial Governance"-Program), and includes a literature review, a historical sketch, an overview of examples and an analysis of the practical and political questions and problems for a university (Newcastle University 2009); see also the strategy 2012: http://www.ncl.ac.uk/documents/vision2021.pdf

Regions" and systematically developed regional development in various regions around the world. The experiences have also been included in the European strategy of "smart specialisation". [23]

In the US research literature engagement is defined as a two-way relationship of the "third mission" being distinct from the past one-way paths (Weerts/Sandmann 2008); concerning issues of definition and benchmarking of community engagement see the *Carnegie Community Engagement Classification (cf.* Lassnigg et al. 2012:63-73).[24] In Australia[25] and the U.K.[26] we can also find quite extensive work about definitions and classifications. In the U.K. economic and social aspects were definitely combined, and approaches for including engagement into basic funding were sought for. Core aspects of community engagement are students' services and forms of community related research (e.g., translational research; Silka 2008; Ahmed/Palermo 2010).

Universities are perceived as organisations that are not only part of their local and regional environment, but also part of national and international global knowledge spaces. Thus they should contribute, through their engagement, to the integration of those levels and work as nodes of wider global-regional networks in order to combine the external resources with the regional needs (Arbo/Benneworth 2007). . Regional engagement also seems to depend on the age and location of the HE institution, with younger non-metropolitan institutions having a higher engagement priority than older metropolitan ones. Involvement in regional development activities increases engagement. (May/Perry 2006, Uyarra 2010). The US case studies by Weerts and Sandmann (2008) have shown an opposite tendency with metropolitan universities showing more engagement than land grant universities.

Critique, or barriers of the concept

- The concept poses very high demands of coordination, steering and financing to engage comprehensively in the regional environment (Chatterton/Goddard 2000; Newcastle University 2009); it is not clear how the various tasks an missions of HE institutions can be integrated and coordinated; moreover, there are doubts about the capacities and potentials of HE institutions towards this engagement, and their willingness to engage might also be overestimated (Gunasekara 2006).

[23] See http://pure.pascalobservatory.org/projects/current/pure ; see also the booklet reporting about regional initiatives: http://pure.pascalobservatory.org/sites/default/files/Booklet%20of%20case%20studies_Universities%20and%20S3_FINAL%20version.pdf; see Guide to Research and Innovation Strategies for Smart Specialisations. (RIS 3) http://s3platform.jrc.ec.europa.eu/en/c/document_library/get_file?uuid=e50397e3-f2b1-4086-8608-7b86e69e8553

[24] See the description at http://classifications.carnegiefoundation.org/descriptions/community_engagement.php

[25] See Winter, Wiseman und Muirhead 2006, Le Clus 2011, Langworthy/Garlick 2008, Langworthy 2009a, Langworthy 2009b; see also Australian Universities Community Engagement Alliance Inc. (AUCEA): http://www.aucea.org.au/; renamed to "Engagement Australia"; included 30 of 37 public universities.

[26] Hart et al., no date

- The capacities of HE institutions are still mainly governed at the national level, which might reduce their latitude for engagement; this applies not only to the financial resources, but also to the regulations of study programmes, work relations, or incentives at the national level.

1.4 Conclusions

On the background of the debates around the Humboldt-type university tradition the importance of the long-term historical process of differentiation in higher education structures and missions is emphasised, which still leads to widespread attempts to reject or compromise a third mission of the university towards innovation in the economy or society, despite the growing availability and importance of knowledge due to globalisation and the knowledge based economy.

Thus policies towards the knowledge triangle cannot build on the self-evident functioning of the three vertexes in higher education. Moreover, the structural differentiation of HE systems as a reaction to the massification process has created HEIs with very diverse distributions and qualities of the three vertices of education, research and innovation. Consequently the third mission has still to be instituted in large parts of HE, which constitutes a contradictory situation between differentiation and integration. Massification has also to large parts the consequence of financial constraints, which also create barriers to the implementation of an additional mission. Third-party funds cannot compensate for the development work, if market prices for the services must be paid. The spreading use of ICT has enormously increased the access of HEIs to the globally available knowledge, however, to which extent the use of ICT (e.g., through e-Learning) contributes to rationalisation is not clear.

To get a picture of the conditions for the implementation of the KT, the degree and quality to which the three missions are already implemented in a HE system should be measured and analysed. Measurement depends on the concepts and definition of the missions.

Main aspects for an adequate understanding of HE developments towards strengthening the KT are the following:

– Sectorial-institutional vs. functional-institutional differentiation
  The different pathways of European and American HE systems created distinctive institutional preconditions for the implementation or takeover of a third mission.

– Narrow-economic vs. broad-societal innovation
  The different perceptions of innovation long for quite different policies and institutional changes due to defining the Innovation-vertex and the relationship of the vertices towards each other.

As an important part of the knowledge triangle we have reviewed four different conceptions of the “third mission” of universities and HE institutions. The “third mission” has established the third vertex of the triangle. We can see that a wide variety of conceptions exist in the literature, which give the involved actors quite much discretion of how to perform the mission.

The entrepreneurial university appears as the most clear cut concept, which however, seems to have the least communalities with the other conceptions. In this concept the performance of the “third mission” is comparatively strongly differentiated, streamlined and formalised; however, its most important dimension with respect to the HE institutions, the “academic heartland” seems rather underexposed. The other concepts include much more variety and flexibility concerning the activities and the relationships among the actors, and they seem to give more attention to informal aspects.

The engagement concept is somehow an opposite conception to entrepreneurship, however, appears relatively weakly conceptually developed and empirically analysed. This conception has much in common with the “mode 2” concept concerning the views about knowledge production and about the “boundary spanning” between internal and external actors.

Overall, these analyses give an impression of the complexities which are included in the KT, and the wide variety of activities to approach them.

2. Summary of the analytical framework

The analytical framework has been created by the authors in order to gear the analysis towards the challenges, policy questions and roles of the various stakeholders related to the knowledge triangle. Two overall steps are taken for the analysis: first we look at the position of each of the vertices (education, research, innovation) in relation to the triangle; second we analyse the shape of the overall KT policies according to a set of five more synthetic aspects. The materials used are comparative studies at the policy level, and reviews of academic and policy literature that look at the vertices and the edges of the triangle. We have shown in the outset that academic evidence about the overall triangle is lacking, so we look at the elements. We take a hierarchical view that first relates the elements to the KT policies and then looks at the overall three-way policies, which are not very much developed so far.

2.1 Challenges included in the concept of KT: turning policies from differentiation to integration

If we consider the performance of three distinct missions by HEIs, there can be different distributions of them, and as each of the missions needs the appropriate resources (personnel, competencies, financing, etc.), their variation or recombination must have consequences in terms of resources in the broadest sense. Increasing one mission at a given level of resources creates trade-offs, and poses questions concerning the 'worth' of activities. How does the differentiation/integration alternative influence these trade-offs?

2.1.1 Education related to the KT

Differentiation/unity of the two-way relation of education and research

The structuring of HE systems is up to now strongly related to different configurations of education and research. The third mission has not emerged towards a similar structuring element so far, rather differentiations according to the traditional linear model prevail as guiding concepts, particularly basic and applied research, and development. According to a different positioning of HEIs at the traditional missions, the conditions for the positioning of the third mission of innovation will vary, and thus the configuration towards the KT.

Education related to research/innovation

An issue (to some extent implicit) in education at the level of HE is the question of whether it is geared towards research practice or towards professional or vocational practice, and related to this, the question, to which extent competencies needed in research are generally considered a part of education at this level, or rather separated in specialised units (graduate

or doctorate schools vs. professional schools). There is much diversity in these issues related to disciplinary and institutional structures, and the Bologna process and the qualification frameworks are also related to this issue, as the access to research and professional competences is differently allocated to the different levels.

2.1.2 Research related to the KT

Differentiation/integration of categories of research/knowledge production

Different types of HEIs have different positions towards different categories of research, and thus can give different inputs towards innovation. The traditional distinctions of basic and applied research have been extended towards various categorisations of research/knowledge production during recent decades in scientific discourses, which are also related to differentiations in the HE field (e.g., various kinds of blurring distinctions between basic and applied research, research towards truth or use, 'use-inspired basic research', dimensions of disciplinarity vs. inter- or transdisciplinarity, action research and reflective practice, community oriented research). These differentiations also concern the different forms of innovation (DUI vs. STI), as well as different fields of innovation (business vs. social).

2.1.3 Innovation related to the KT

Differentiation/integration of innovation as a basic mission in HE

Here that main issue concerns the manifold consequences of the differentiation of a third mission, and also whether the relationship of higher education towards innovation is explicitily institutionalised as a separate function, and to which degree this function is given weight in the system, and in different sectors or institutions of the system. A particular issue is, to which degree the third mission is part of the institutions traditionally related to basic or pure (academic) research (the core 'research universities'), or allocated to other kinds of (specialised) institutions. Should the third mission be funded by some part by the general budget, if it is considered a basic mission?

2.2 Policy challenges

The policy challenges are related to goal setting on the one hand, and to governance on the other. To push higher education towards a business-like sector ideally would make it self-regulated by the market, and consequently political influencing would become more indirect, e.g., by incentives or financial instruments. There are longstanding debates about balancing the public and private functions, and about proposals to increase the role of the market in a carefully regulated form. How policies in these directions work is only known to some part, and there are also issues concerning the acceptance of different policy instruments or

strategies at this level. With the entrepreneurial university a strong paradigm seems to have emerged during recent decades.

2.2.1 Influencing autonomous institutions in their core tasks

Traditionally there is a divide between public and private institutions in HE to different degrees in different countries or systems. Recent policy developments have geared much attention to the relationship of public and private financing of HE, however, the channels of these kinds of financing are not so much clear, as financing of education and financing of research is provided through different channels. Financing of innovation still remains a separate issue. Public money can be conditional to certain goals and objectives; private money is due to the financiers. According to the entrepreneurial model the HEIs should be increasingly responsible for the financing portfolio. Attempts to influence the performance become increasingly complex.

2.2.2 Performance at the vertices and balance between them

The working of the KT depends on how the HEIs perform at the vertices, and how their relations are shaped. It is clear that they depend on each other, however, how the relationships (can) contribute to the KT is altogether not clear so far. The KT can be seen as a device for the development of certain balances here. To understand the working of the KT the performance at the vertices, and their relationships must be analysed. Models for this analysis do not exist so far (e.g., composite indicators may be developed, and as a basis for this the interrelations must be analysed in a three-way framework that analyses the relationships in a hierarchical or then, based on this also in a non-hierarchical way: how do the functions contribute to the overall performance? how do certain two-way interrelations contribute to the third function? etc.).

2.2.3 Developing the external environment of institutions

The KT clearly cannot be implemented at the level of HEIs alone, as the institutions are part of aggregate relationships, which exist and evolve without the influence of the HEIs. E.g., the overall innovation activities and practices in the economy and society are – despite they might be influenced by it – mainly a given for the HE system. Here also the processes of internalisation and globalisation play their role, which are reflected in the internalisation and globalisation of HE and HEIs (e.g., the big ‘global research universities’). KT policies involve certain relationships between attempts to influence the HEIs, and policies at the aggregate level, which are not clear so far.

2.3 Challenges concerning stakeholders

The KT involves many different (kinds of) stakeholders, which have been identified already in the different versions of innovation systems and have been further structured by the models

of the triple helix and their successors of quadruple, quintuple, etc. helices. It is clear from this previous research, the performance of innovation depends much on the interrelations and cooperation between the various stakeholders. It is also clear that these interrelations are diverse and complex and difficult to govern. At some points there is knowledge about the interrelations available, however, to some extent they are also under dispute. Similar to the governance of HE, the question about the establishment of markets vs. other mechanisms prevails at this level of the interrelations between stakeholders also. Important issues are the creation of various kinds of institutions (e.g., IPR, TTOs), the development of direct communication and cooperation (local, regional, sectorial, national innovation systems), and the engagement of HEIs.

2.4 Analysis at the level of three-way interrelations in the KT

At this level, as a device for the analysis of the existing KT policies we have formulated the following more concrete dimensions, which cover the overall framework to some extent.

Differentiating or unifying HE systems

Currently various patterns of differentiation of HE systems, and different relationships to vocational and professional education exist. Policies towards developing or implementing the KT – either on a national level or as a concept for the mission of HEIs – must take this differentiation as a starting point and consider how the KT should be situated. Policies towards the KT can either foster the unification of HE systems by encouraging all types of HEIs to implement the KT within or hinder this integration by designing policies which assign each type of HEI a specific place in the KT.

Broad or narrow definition of Innovation

While education and research are established missions of HEIs across all subjects, innovation is often used in a narrow definition only. These concepts are variably narrow. Some are defined by the field of innovation, e.g. S&T innovation only. Others define innovation activities as all kinds of interaction of HEIs with business and industry with an immediate return.[27] A broader concept of innovation takes into account all innovative actions and actions fostering innovation and thus also includes the engagement of universities with their communities or social innovations.

Mode of Third Mission

Although this differentiation is somehow overarching some other points of difference, the four approaches to the concept of the third mission of HEIs presented above, serve as tools for understanding of the internal changes in HEIs and the external catalysers of these changes.

[27] These notions used to be the dominant concept for the measurement of innovation since the 1980ies.

E.g. the entrepreneurial university can be either understood as imperative for researchers to commercialise their research findings or as a concept of enabling and empowering researchers to increase their autonomy by diversifying their research funding. These differing perspectives are interlinked with the question about the endogenous or exogenous character of the implementation of the KT in HEIs.

Exogenous or endogenous policies

Policies regarding the KT but also analytical papers can be roughly characterised along two categories: On the one hand, they address the construction or constitution of an environment that generates or support aggregate relationships according to the integration of education, research, and innovation. The In this kind of policies HEIs respond to their environment. On the other hand, the implementation of the KT can be attempted within HEIs, e.g., supporting or demanding their engagement in innovation and business. Policies can be targeted towards the HEIs themselves, to increase their activities, or towards the external players (e.g., business and industry) to strengthen their contact with HEIs.

Level of implementation, level of action

KT policies can be designed and implemented on different levels. Especially the European Union formulated the KT as an objective in its educational and economic development. Other entities like the OECD, nation states, regional authorities, or institutional bodies also develop policies aiming at the implementation of the KT. These policies address different actors at different levels. E.g. a supra-national policy encourages nation states to undertake actions, which result in national policies addressing institutions or regional authorities or HEIs. Policies may also take the short cut, calling on institutions or individuals to work towards better linkages between education, research and innovation.

2.5 Remarks concerning the use of the framework

This framework can only be filled to some parts in this expertise, to some extent because the material is lacking the necessary information, and to some parts because the task exceeds the resources. However, the framework might give guidance for the further steps in the overall activity.

The framework shows to which dimension the KT is a demanding concept, whose implications are only clear to a small extent so far.

3. Analysis

3.1 Education and the KT

Education (teaching is to some extent used interchangeably) at the HE education level is traditionally perceived in a different fashion, compared to other sectors of education and training. This concerns on the one hand the content, which is not only more demanding, and more complex, but also carries the notion of the education of a selected group of the population with specific professional and ideally also social responsibilities. Parts of higher education also are selecting the elite. The particular status of HE is reflected in the 'Dublin Descriptors'[28] for the qualifications framework, by denoting specific dimensions, and in particular including the dimension of '*making judgements*', that points to the wider responsibilities of the graduates (whereas the European Qualifications Framework only included the dimensions of knowledge, skills, and competences).

On the other hand, teaching in higher education has traditionally – rooted in the elite system – also a specific methodological standing, as in most cases a specific training or education for teaching purposes is neither required nor available. The disciplinary or subject knowledge is mostly the main requirement, and particularly in universities traditionally teaching should be combined with research, and the students are considered adult persons who should be able to have acquired their sufficient learning skills (and who have not, are selected out). In the research university, when teaching and research is combined, specific attention or training for teaching has opportunity costs by taking time from the principal task of research (see Geschwind/Broström 2013 about Sweden, or Ramsden/Moses 1992 about Australia). An important factor is also the professional tradition that has added a compulsory period of practical training after studies in higher education (a tradition, which was often not followed in the various new subjects in HE).

The advent of mass higher education has changed this situation to some degree, as specific sectors or institutions emerged with main teaching functions. However, the disciplinary and subject knowledge prevails as the main criterion, and often practical experience in the field outside the university is added. University teaching as a specific field of research and education emerged to some degree, however, its status is still widely questioned or under dispute. A key factor that increases the difficulties of teaching is the high degree of differentiation and specialisation in HE, which requires much specialised approaches towards teaching methodology. If we look at the research about teaching in higher education,

[28] "The Dublin descriptors were built on the following elements:
> knowledge and understanding;
> applying knowledge and understanding;
> making judgements;
> communications skills;
> learning skills" (Bologna Working Group 2005:65).

we can see huge disciplinary differences. We can see the most elaborate research about teaching methods in medicine, where the journals regularly include publications about results and effectiveness of teaching and learning methods. Overall an international body of knowledge has emerged since the 1980s about academic staff development or faculty development (UNESCO 1995, Brown/Atkins 1993), which, however, has still more or less marginal status in many systems. There are big questions about the impact of training on the teaching and learning results, which are not resolved. Mostly there are small studies available, and reviews report some positive effects, but not much impact.

As an example, in Germany a tradition of 'Hochschuldidaktik' has been built up since the HE reform in the late 1960s by engaged academics, however, the whole enterprise is still highly under dispute. In the late 1990s a big public debate has been started by a prominent academic, who publicly called these attempts 'instruments of torture (Marterwerkzeuge)' without any positive impact (see the rejoinder by Huber 1999, a pioneer of Hochschuldidaktik). In England, related to the widening access movement, instruments for improvement of teaching have been set up (the Higher Education Academy, and the Centres for Excellence in Teaching and Learning CETL), and research results have been summarised (TLRP n.y.)[29]

Education and teaching in HEIs are basically related to innovation through two – to some linked – but mainly different channels: (i) through education for research which can contribute to innovation, (ii) through professional or vocational competences that can contribute to innovation via the supply of human capital. These two channels represent the differentiation of HE systems. Interestingly, in the discourse and practice towards the knowledge triangle, mostly the channel (i) is considered, whereas HE increasingly produces human capital via the channel (ii). To some extent this distinction also reflects the conflicts between teaching and research, and the differentiation between the cycles of HE.

If we consider the channel (ii), many questions arise, which also relate to the different modes of innovation. How can innovative practices, which are at any point marginal, be reflected in teaching? What is the role of the new graduates in the innovation processes? To which degree is innovation not (directly) related to research? How important is the research-teaching nexus for innovation? Answers to these questions are important to bring education appropriately into the knowledge triangle. Here the role of incremental innovation that is not directly research related must be taken into account, which is often neglected in research and policy making (Huang/Arundel/Hollanders 2010).

[29] Higher Education academy: https://www.heacademy.ac.uk/; CETL: http://www.hefce.ac.uk/whatwedo/lt/enh/cetl/ CETL "represented HEFCE's largest ever single funding initiative in teaching and learning. The initiative had two main aims: to reward excellent teaching practice, and to further invest in that practice so that CETLs funding delivered substantial benefits to students, teachers and institutions. Funding for 74 CETLs totalled £315 million over five years from 2005-06 to 2009-10. Each CETL received recurrent funding, ranging from £200,000 to £500,000 per annum for five years, and a capital sum ranging from £0.8 million to £2.35 million." (HEFCE webpage)

3.1.1 The role of education in policies at national level

Innovation and research policies are closely interlinked in most OECD countries, whereas education policy is rarely mentioned as a key component of policies. Only the support of entrepreneurship education is defined as a policy objective in several countries. Education policies that go beyond fostering entrepreneurship education are mentioned in knowledge triangle policies of six countries, namely Canada, Germany, Iceland, Netherlands, Mexico and Portugal.

In Canada, education policy is included in the knowledge triangle through the Canadian "Collaborative Research and Training Experience" (CREATE) Programme. This programme supports the training of teams of highly qualified students and postdoctoral fellows through the development of innovative training programmes. Funding may be applied by a group of accomplished researchers who offer a specific research training programme to a group of trainees (master's, doctoral and postdoctoral students; undergraduate students can be included as well in some cases). These programmes should address significant scientific challenges within Canada's research priorities and foster the transition of researchers from trainees to highly qualified employees. In addition, these programmes should encourage student mobility, (nationally or internationally, between individual universities and between universities and other sectors), increase collaboration between industry and academia and support improved job-readiness within the industrial sector. The programme's disciplinary focus lies with natural sciences and engineering.

The German "High-tech Strategy 2020" (introduced in 2010) predominantly focuses on innovation and research policies. However, it includes some measures within education policy as well, such as the "Pact for Higher Education 2020" and the "Initiative for Excellence" that is aimed at improving the science location Germany and its competitiveness. The initiative contains three project-oriented lines of funding: Funding of "Future concepts for top-class research at universities", "Clusters of Excellence" in specific research areas and "Postgraduate schools". These Postgraduate schools for young scientists are an example for an education policy measure within the national knowledge triangle policy. About 40 postgraduate schools are funded in order to provide optimal conditions for young people pursuing a career in science. The "Pact for Higher Education 2020" determines federal higher education funding with the objective of sustaining and improving both the quality of research and teaching as well as the capability of universities to cope with an increasing number of students.

In Iceland, education policy is included in the knowledge triangle through the University of Iceland's "Institute of Research Centres". The institute was established in 2003 and supports the University's collaboration with local authorities, businesses and individuals in rural areas. So far, seven centres have been established. The institute's objectives are – amongst others – to provide facilities for students' field work and increase access to research based

education in rural areas. In 2013, the centres employed 30 people, among them permanent staff, part-time staff and students. However, no further information regarding the actual implementation of the objectives related to education policy could be found.

The "Quality in Diversity" strategic agenda (2011) contains several education policy measures that are considered as part of the Dutch knowledge triangle policy. It has a long-term perspective on higher education, research and science and serves as basis for collective and individual performance agreements with HEIs regarding quality, profiling and valorisation. The strategic agenda is aimed at a substantial restructuring of universities' range of programmes provided at HEIs with the ambition of significantly reducing the number of programmes (including periodically conducted analyses of the existing range of programmes). One objective is to provide more room for broad-based bachelor and professional master degrees. Within professional higher education an associate degree will be established as well as three-year tracks that will be made possible for pre-university educated students. Meeting labour market needs is introduced as an explicit criterion in the macro-efficiency check that is conducted in the process of authorising new programmes. Other measures that are aimed at a greater labour market relevance of higher education are labour market analyses, labour market relevance as a weightier criterion in the funding of new programmes, increased inclusion of employers in higher education and improved information to prospective students about the labour market prospects of higher education programmes. In order to strengthen flexibility in higher education for the workforce, more room will be created for part time programmes.

In Mexico, education policy measures are included in the knowledge triangle through the "business schools programme" and the "Post-graduate degrees with Industry" programme. The business schools programme promotes the participation of enterprises in the development and use of academic programmes and is addressed at micro-enterprises and SMEs, innovation networks, HEIs, and research centres. Through this programme, enterprises may receive financial support for training and the increase of internal competences in technology-related areas. In addition, HEIs and research centres receive funding in order to provide tailored short-term academic programmes (maximum of 11 months) as a clear response to the market demands of the private sector. The "Post-graduate degrees with Industry Programme" (introduced as part of the "Excellence Postgraduate Programme" in 2012) is aimed at finding new ways for enterprises, HEIs and research centres to jointly organise postgraduate studies that link science with industry. Within the programme, HEIs and public research centres may obtain a quality certification that attests the industry orientation of post-graduate degrees. In 2012, the programme focused on applied sciences in the fields of engineering and technologies, biotechnology and agro-fishing sciences.

The "Strategic Programme for Entrepreneurship and Innovation" ("+E+I", 2011) in Portugal appears to include education policy measures in the knowledge triangle policy. One measure

is aimed at “promoting the experimental drive in basic and secondary education”, another one at fostering entrepreneurship education. However, there is no information regarding the actual implementation of these objectives.

The Canadian and German programmes are mostly oriented to the channel (i) of education for research, whereas the programmes in the other countries also consider the channel (ii) of the creation and use of other competences for innovation. The following examples show different versions of the support of entrepreneurship education. In Denmark, a new initiative for the strengthening of entrepreneurial universities was launched in 2010. One of the priorities of this initiative is the promotion of entrepreneurial training at universities. In New Zealand, entrepreneurship education is provided at many universities – mostly as an elective option for students in various programmes. However, there is no significant effort in terms of nation-wide coordination of entrepreneurship education. In Greece, the Ministry of Education and Religion is encouraging the introduction of entrepreneurship courses in university curricula. In Japan, policy focuses on fostering entrepreneurship education. The number of universities that have implemented entrepreneurship courses and programmes has been increasing gradually since 2001. In Norway, entrepreneurship in education and training has been a prioritised area in the educational policy and is offered at some schools and half of all HEIs. An Action Plan from 2012 stipulates to further strengthen the quality and the scope of entrepreneurship education and training at all levels.

3.1.2 Evidence at the Institutional level

The 2012 report on “Education in the Knowledge Triangle” (Technopolis 2012) examined the integration of the three sides of the KT in European universities with a special focus on education. 12 case studies of flagship institutions show best practice examples.[30] We draw intensely on this study because it analyses different types of HEIs (technical universities as well as universities of arts and an EIT ICT Lab), and because there is very little evidence on the KT with an explicit focus on education. The study tries to close a research gap, since many activities towards the KT have “been associated with technology transfer, enterprise development and the necessary conditions for the translation of research into production, thus focusing on the research/industry link.” Moreover, entrepreneurship was mainly viewed “through the medium of technology transfer, looking at spin-offs, start-ups and potentially

[30] Aalto University, Finland – a student-centred approach to education
Aarhus University, Denmark – a ‘quadruple-helix’ university
Chalmers University of Technology, Sweden – Collaboration across disciplinary boundaries
École Polytechnique Fédérale de Lausanne (EPFL), Switzerland – open innovation in education
Université Joseph Fourier, Grenoble, France – embedding in the region
Karlsruhe Institute of Technology, Germany – working across the disciplines – House of Competence
Mondragon University, Spain – the Mendeberri educational model
Umea University, Sweden, the knowledge triangle in the governance model
University of the Arts London, UK, Flexible innovative teaching models in the creative arts
University of Trento, Italy, the knowledge triangle in regional innovation
University College London, UK, a comprehensive university with a focus on future grand challenges
Zürcher Hochschule der Künste, Switzerland, transdisciplinarity in the Arts

student enterprises." Which leads to the conclusion: "Despite the interlinked nature of the relationships in the triangle, there is a concentration on the diffusion of knowledge rather than a bidirectional flow." (Technopolis 2012:14f)[31]

The findings from the case studies show the capability and potential of individual HEIs, each one embedded in specific national HE and KT policies, to take action toward strengthening the link of education to research and innovation. According to the findings presented, most of these actions are transferable, although they often refer to very specific national or regional environments. However, one prerequisite of all of these actions is a high degree of autonomy of the respective HEIs. The recommendations drawn from the report point toward a comprehensive KT policy at the institutional level:

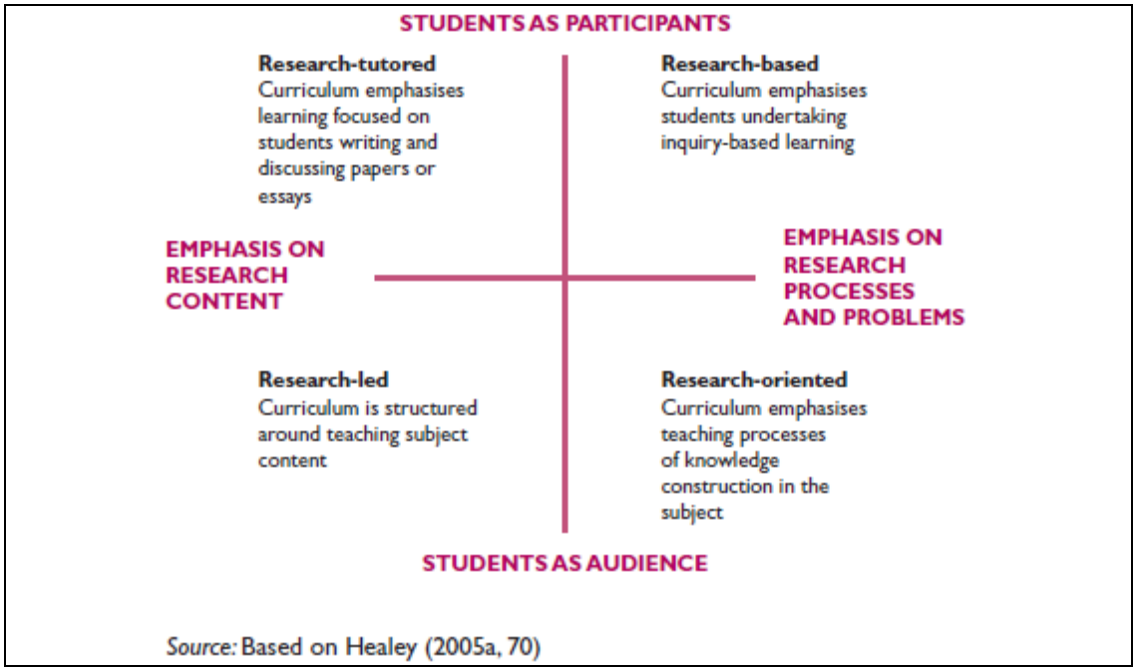
"Embedding the entrepreneurial culture throughout the higher education institution [...]
Involving students as co-creators of knowledge and as part of the innovation system [...]
Creating rich learning environments for talent development [...]
Quality assurance and recognition of new skills development [...]
Taking an interdisciplinary approach [...]
Developing academic talent [...]
Internationalisation 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 knowledge triangle related activities in the university strategy [...]
Smart specialisation as a focus for knowledge triangle activities [...] Smart specialisation implies concentrating resources on a few key priorities based on a region's economic potential [...]
Taking the longer term vision for change at the institutional level [...]
Incentives and funding structures [...] consider incentives […towards; authors…] education, business relations and other third mission activities. Competitive research funds in particular might be encouraged to look at all three sides of the knowledge triangle and treat them more equally. [...]
Engaging with the national policy environment across the areas of research, education, enterprise and innovation" (Technopolis 2012:54f)

The findings of the presented study suggest to link teaching better to research and innovation. The case studies present very individual ways of doing so, which is at the same time a strength and a weakness of the study, since the concrete measures are not that easy transferable. Thus, a more elaborated supra-institutional approach of HE didactics is presented in the following.

[31] Page numbers refer to the actual position in the PDF-document because of inconsistencies in the document's numbering.

In Australia and New Zealand but also in the Netherlands, the need to rethink curricula about their ability to qualify graduates for highly knowledge intensive areas resulted in the development of the so-called “research-teaching nexus”. The RT-nexus goes beyond the Humboldtian idea of teaching, as the concept suggests further more activating modes of linking teaching and research to each other (research-led teaching is in fact the least activating mode of teaching, as shown in figure 5). This pedagogical approach aims both at the employability of graduates in the knowledge society but is also targeted at the mentioned function of academic reproduction. The foundations of the modern RT-nexus can actually be traced back to the same year, as the Frascati Manual: In 1963, the Robbins Report on the future of HE in the UK stressed an understanding based on partnership of students and teachers, both engaged in learning and research. In knowledge based society “[s]tudents” understanding of knowledge generation through research and, arguably, their ability to “do” research, is vital […] in a knowledge society, how knowledge is developed (i.e. researched to create understanding) and transmitted (i.e. taught and learned) is critical.” (Jenkins/Healey/ Zetter 2007:12)

Figure 5: Curriculum design and the research-teaching nexus



Source: Jenkins/Healey/Zetter (2007:29)

But the interaction undertakes, as mentioned, also a vital function for universities and the researchers and scholars do not keep their two-fold ambition a secret. The teaching-research nexus, does not only improve students employability but also aids “students’ learning, their pride in their discipline and department, staff morale, and the overall effectiveness of the department and the institution.” (Jenkins/Healey/Zetter 2007:76)

Finally, an attempt to strengthen the link between education and research could also aim at the university staff. Academic staff doing both research and teaching, is mainly concerned with their academic, i.e. research output. Therefore, a strengthened research-teaching nexus could also add up to the prestige of teaching activities. By now, appreciation of teaching quality is mainly expressed via awards; strengthening the nexus would require making teaching activity and quality and integral part of the academics job description.

3.1.3 Conclusion

Comparing national policies on education in the KT with the institutional approaches found in the case studies shows that most national policies are rather vague about the way of strengthening the ties of education to research and innovation. In entrepreneurship education the best practice examples did not just add some courses to the curriculum but worked towards a culture of entrepreneurship throughout all activities of the HEIs.

The best practice examples rely heavily on the high degree of autonomy of the HEIs. Thus, national policies are even less able to affect this institutional praxis. Nonetheless, the efforts undertaken in Canada, Germany, Iceland, the Netherlands and Mexico might foster similar institutional developments. The Canadian "CREATE" approach is likely to apply aspects of the described RT-Nexus (although at post-graduate level only) and funds these training schemes competitively, which is also an indicator for higher valuing teaching and thus making teaching and innovation in teaching more attractive for academics to invest in, since they contribute visibly to their academic career. The German "Exzellenzinitiative" is also an example for revaluing education and, as recent media reports suggest, the criteria for funding will shift even more towards excellence in teaching (besides research).[32] The case of Iceland is a good example for the combination of research driven education and responsiveness to local business. The Mexican approach is somehow similar, since engagement of HEIs with local SMEs for education, research and joint innovation is here too at the heart of the measure. The "outsourcing" of some teaching activities can further be understood as a way of fostering the inclusion of transversal skills and the recognition of learning activities undertaken outside the HEI. The largest scope of educational KT policies undertaken on national level can be found in the Netherlands. The strategy of reducing the overall number of programs, broadening BA programs and considering labour market developments for design and funding of programs seems to target HEIs autonomy quite directly, which reflects the tradition of political interference in HE policy (Maassen et al. 2011:489).[33]

The overall trends in HE policies anyhow point rather towards more autonomy of the HEIs. This was also stressed in the IMHE report on quality teaching (OECD 2012a) when stating

[32] http://www.sueddeutsche.de/bildung/deutsche-hochschulen-politik-plant-auch-kuenftig-foerderung-exzellenter-unis-1.2182476 (in German, published October 20th, 2014)

[33] Unfortunately, this paper could not yet take the cited strategy into consideration.

"Quality teaching policies should be designed consistently at institutional, programme and individual levels" (OECD 2012a:10). Many others of the lessons learnt/ recommendations stated above found their equivalent in the OECD paper on Quality Teaching. Some measures described there are actually designed similar, e.g. the reward system at the Université Laval (OECD 2012a:16), the teaching students at the University of Campinas (OECD 2012a:22f), or the inclusion of teaching standards into the overall quality assessment at Macquarie University (OECD 2012a:39). However, the Quality Teaching project followed more or less a one-directional approach "designed to help higher education institutions more effectively carry out their teaching mission, thereby contributing to economic growth, innovation and social well-being in their respective countries" (OECD 2012a:51). For a coherent KT-approach, the mutual effects of all three components have to be examined in more detail.

3.2 Research and the KT

Much evidence is available about the relationship between research and innovation. This must not be repeated here. We rather point to some controversies and open questions which might affect policies in the KT.

A first issue concerns to extent of non-research based innovation, and its consequences. In some countries with strong vocational education systems, in particular the 'core apprenticeship countries' (Germany, Austria, Switzerland) show indications that incremental innovation ('modifiers' in statistical terms) is high and enterprise based vocational education oriented to practical competences is seen to some part as an alternative to R&D innovation and further expansion of higher education. Recently quite aggressive discourses against further 'academisation' are run in some of these countries, and overall there are debates and indications concerning 'overeducation'. Whereas there is much evidence about the economic impact of 'radical' R&D innovation, the alternative of incremental, non R&D Innovation is very little analysed so far. This is due to the lack of empirical information about this kind of innovation. On the one hand vocational education is differently distributed at the secondary and postsecondary or tertiary levels, and thus the comparative data do not give a good picture about the supply side. On the other hand, the different kinds of innovation cannot be seen in the available data (the European Community Innovation Survey has been used for this purpose, and some national surveys have also been used, e.g. in Denmark). This information is punctual and cannot be used for the analysis of effects on growth or productivity. Researchers that have worked with this data do rather not see incremental or non R&D innovation as an alternative, but rather complementary (Nielsen/Lundvall 2005, Lundvall 2008), or as an indication for a lack of resources (Huang/Arundel/Hollanders 2010). Contrary to the emphasis on vocational education and incremental innovation are the new results about future changes in the employment structure because of increasing

computerisation which might affect many jobs in the middle ranges and lead to a net loss of employment (Frey/Osborne 2013).

Other disputed questions concern the issues around the Intellectual Property Rights and Academic Capitalism. To which degree do the shifts of property rights to the HEIs or to the individual researchers lead to an increase in innovative activities? Or do these polices inhibit innovation? Is Open Innovation a more effective alternative? There have been heated debates about these issues which have been in the meantime to some extent settled (Grimaldi et al. 2011). There have been positive incentives, particularly in certain areas (Biotech), however, much smaller ones than expected. Basic research has not been damaged, and the alternative between IPR and open source innovation is seen not a fundamental but a more pragmatic one, with an essential role of open innovation in exploratory research (David 2003). In reality, however, there seems not a pragmatic choice but a strong 'policy drift' towards the

Choosing the regime depends consequently on the emphasis that should be given to the different categories of research. The research and innovation performance of the US system is appreciated, whereas in Europe the gap between research and application is considered a longstanding problem. Thus the focus is on the improvement of research use. At this point the third mission comes into play, and research displays different facets of how this mission can be developed or implemented (see sections 1.2 and 1.3). Two issues arise, (i) how broad the third mission is developed according to the four types, and (ii), how the relationship between research and innovation is shaped: (i) the breath of the third mission is ultimately a normative question, which cannot be resolved by evidence. We can only find evidence how this mission is implemented, and we can analyse needs, and how the various stakeholders act according to these choices; recently a narrow perspective towards economic innovation is dominating, at least at the policy level, whereas the HEIs and the academics to some part prefer broader meanings. (ii) the configuration of how the relationship between research and innovation is shaped is related to the differentiation of the HE system and the division of labour between different categories of knowledge production. The core concept is transfer, and the shape of the third mission is related to the distance between the actors in research and the actors in innovation. It is clear from innovation research that an invention does not or seldom directly result from research, and that subsequently there are several steps between an invention and an innovation. This process can be devised and organised differently, and its configuration will depend on many factors. In the traditional linear model a kind of production line was devised, including different actors 'downstream' from basic research to development. The actual question is, how far this way must and can be shortened, e.g., to cope with the increasing time pressure. In other words, the question is, to which degree innovation can be brought directly together with research. A very close connection is the idea at the core of the third mission; this means that the researchers are involved also in innovation. The concept of transfer involves basically some separation and bridging, and the creation of separate institutions. Alternative views related to

concepts of the innovation system (e.g. Lester 2007, and the subsequent work in the M.I.T., or the concept of 'use-inspired basic research') emphasise the direct communication between the players in research and innovation, on the one hand to receive questions, on the other hand to develop answers more directly in the core of research. However, this means that additional demands on research come not only from the education/teaching side but also from the innovation side.

3.2.1 The role of research in national policies

Most policies on country level seek to strengthen the ties between research and innovation. However, policies do only seldom explicitly differentiate between the research at HEIs and other (public) research institutions and research activities undertaken by firms. This is quite surprising, since e.g. the OECD Science, Technology and Industry Outlook 2014 (OECD 2014b) states explicitly, that there has been a shift of research intensity from public research to HE:

> *"Public research has changed in many OECD countries. Universities have taken the place of PRIs as the main performer of public research. Higher education expenditure on R&D (HERD) has increased steadily over the past decades in the OECD area as government expenditure on R&D (GOVERD) has declined […]. An important reason has been the universities' teaching role and the major contribution to innovation of knowledge embodied in persons and skills that research universities nurture (IPP, 2014). This knowledge is especially important for research students, many of whom seek long-term careers in business firms." (OECD 2014b:196)*[34]

There actually seems to be a lack of research policies designed specifically for the HE sector. The OECD report does mention a number of initiatives for inter-sectorial mobility and cooperation, but at the same time, the lack of coherence is obvious: Research policies are aware, that universities (and public research institutions) play an important role in basic, long-term, high-risk research with uncertain outcomes both in terms of results and in short-term applicability of research results. At the same time, there is a growing concern about the commercialisation of publicly funded research (OECD 2014b:211). And while there is a growing concern about the efficiency of policies on commercialisation of public research[35] there seem to be little new ideas to tackle this. Most country policies still bet on technology

[34] Note that this data is from the Innovation Policy Platform (IPP) and refers to STI research. When a broader innovation concept is applied, this shift would be presumably even more significant.

[35] "Average annual growth of university patent applications fell from 11.8% between 2001 and 2005 to 1.3% between 2006 and 2010. PRIs experienced negative growth of -1.3% over the latter period, compared to growth of 5.3% growth between 2001 and 2005. Data on disclosures of invention (the first official recording of an academic invention) per USD 100 million in research expenditures show a slight average drop from 2004-07 to 2008-11. University spin-offs have not significantly expanded, despite continued policy support; in the United States, among 157 universities, the annual average number of spin-offs per university is only four. Data on spin-off companies per USD 100 million in research expenditures in major OECD countries generally hit a low in 2008, with the ratio stabilising in 2009-11 at pre-2008 levels." (OECD 2014b:211)

transfer offices (TTOs) and technology licensing offices (TLOs), an increasing number also implemented standard licence agreements (OECD 2014b:213), some of the latter may be oriented towards the Bayh-Dole Act (besides the mentioned examples, also Japan introduced a similar legislation).

3.2.2 Evidence at the Institutional level

For the analysis of the institutional view on research in the KT, we refer to a project on the cooperation between higher education and public and private organisations in Europe. As a part of this study, a major survey among academics and HE administrators was conducted, with a final sample of about 6.280 researchers, HE representatives and professionals of the HEIs working with business (UBC 2011:36).

The main scope of the study was to examine factors, barriers and possible supporting mechanisms to engage researchers with business. Very interesting findings are the disparities between academics and other HE personal in assessing benefits, barriers and supporting mechanisms, which indicate a kind of cleavage in the understanding of university-business cooperation (UBC) at the level of HEIs. Regarding benefits, academics rate the benefits of UBC for themselves the lowest, while HEI representatives rate positive externalities (social and recreational benefits) the lowest. Both groups however perceive students and HE graduates the major beneficiaries, seeing them profiting from UBC more than (local) business.

Academics and other HE representatives did not differ significantly in their responses about barriers towards UBCs – with one exception: academics rated bureaucratic obstacles (very) high, while HE authorities do not perceive them a major obstacle. Besides that, the major obstacles both groups agree on are lack of funding for UBC, and relational barriers between stakeholders.[36]

When it comes to the drivers of UBCs the highest importance (average ratings 7.5 to 6.5) was assigned to “Existence of mutual trust”; “Existence of mutual commitment”; “Having a shared goal”; “Understanding of common interest by different stakeholders (e.g. universities; business; individuals; students)” and “Prior relation with the business partner”. While these are all relational aspects, all business drivers were rated significantly lower. Especially “Commercial orientation of the HEI” and “Access to business-sector research and development facilities” scored least.

[36] “Lack of external funding for University-Business cooperation”; “Lack of financial resources of the business”; “Lack of HEI funding for UBC” all scored an average of at least 6.7 on a 10-point scale; relational barriers such as “Business lack awareness of HEI research activities/ offerings”; “The limited absorption capacity of SMEs to take on internships or projects”; “Differing time horizons between HEI and business” scored all over 6.5 on the same scale.

The survey looked also at situational factors, such as years in business, academic field and type of HEI and crossed them with types of UBC. In many aspects, the findings were not surprising. For instance, academics in technology and engineering maintain the most and most intensive relationships with business, such as collaboration in R&D, mobility of students and commercialisation of R&D results. But also academics in the social sciences collaborate with business in R&D and UBCs of social scientists are strong in the field of Lifelong Learning. The report differentiated five types of HEIs, universities, universities of applied sciences, polytechnics and technical universities, schools, and colleges. The results show, that polytechnics have the highest degree of UBC, academics at these HEIs cooperate in R&D, mobility of students, commercialisation of results, curriculum development and lifelong learning. Since we learned before, that academics in technology and engineering are best in UBC, this is not surprising. Academics start getting involved with UBCs significantly only after 5 years at the HEIs; “It was found with only two exceptions, those academics with more than 10 years in a HEI cooperate the most in the 8 Types of UBC.” (UBC 2011:71).

The researchers finally examined the interrelation of UBC engagement with the issued strategies on national and institutional level using a multivariate model and decomposing the influencing factors (UBC 2011:79 et seqq.). The results are quite definite: documented strategies, visions or external promotion of UBCs show little effect; actually effective measures are the inclusion of UBC as part of the assessment of academic work performance and the dedication of resources (personal and financial) to UBCs.

3.2.3 Conclusion

As for the education vertex, also the research vertex seems to be hard to be addressed by national policies. Although the found policies offer some incentives for business collaboration to the industry (e.g. tax allowances), the main driver for academics to get involved with business and contribute to this kind of innovation activity seems to be (just like for the mission of education) the integration of this collaborations into the academic profile/job description. This is not to be underestimated – in the end, cooperation is carried out by individuals, integrating innovation as a third mission to HEI means consequently integrating innovative activities to the (self-)perception of researchers.

But this obviously needs time. The fact that it is not the young researchers/academics who undertake the most UBCs but the established ones (10 years or more at the HEI) is something to be considered in its consequences: policies for the promotion of young and early-stage researchers and policies of tenure tracks and career development opportunities for academics are likely to become crucial for the innovative potential of HEIs. Or taking the negative perspective: a high degree of fluctuation and constant drive for mobility of young researchers may have a negative backlash on innovation potential of HEIs. This is also in accordance with the need for long-term perspectives and constancy for the sustainability and success of research groups (cf. Kjelstrup 2001).

The study on UBCs in Europe raised an issue, not yet discussed with regard to KT policies: different types of HEIs have different possibilities and capabilities to cooperate; they have different traditions and self-conceptions which facilitate or hinder efforts towards cooperation. E.g. the fact, that researchers at full universities are less likely to be engaged in UBCs than researchers in polytechnics or at universities of applied sciences is not only related to their differing academic fields. When UBCs or other innovation actions become part or core of national funding schemes, these different starting points have to be considered. Eckel (2008) discusses in his analysis of mission diversity and institutional differentiation in the United States that "public policies must be able to take a long-term view, otherwise institutions can easily get caught out by short-term objectives that run at cross-purposes with one another […] The challenge […] is to find ways to reshape what institutions compete over, how they compete, and the incentives to compete so that effectiveness and not simply prestige become the prized objectives." (Eckel 2008:189)

3.3 Innovation and the KT

Innovation is the newcomer in the triangle, and it sets new demands on the other vertices. In Europe the demand was from the beginning of innovation policy to bring research to application. However, the perception at the political level says that the various attempts for reform did not work, whereas the development in the US is perceived much more satisfactory. Maassen/Stensaker (2011) show drastically that actually the reform pressure from the European institutions on HE is increasing. On the other hand more recent research in the US about innovation in manufacturing draws lessons from the institutional framework in Europe (Germany) and looks to the potentials of China (Berger 2013).

One challenge is to devise the third mission in an appropriate way. We have shown that there is a wide space to do this. A first question is how to find the way for an appropriate model or version of the third mission. Concerning the development of the relationships in the triangle one challenge concerns the direct path from education/teaching to innovation. The tasks in teaching for research seem quite clear, and they are taken already by some countries (see section 3.1)

The challenges towards research are to widen the possibilities and to speed up the process, without compromising the core mission of basic research.

3.3.1 The role of innovation in national policies

As for research policies, innovation policies often remain rather vague or one-dimensional when it comes to the specific innovation environment of HEIs. The cited parts of the OECD Science, Technology and Industry Outlook 2014 illustrate this as well as the three-way overview on KT policies provided later in this report (see section 3.3.3 below). In general, innovation policies issued do seldom stress the interrelation of innovation in the KT but do

rather deal with innovation as an end for KT policies. Innovation policies which do contribute to the KT are likely to have a broader focus than S&T only. This applies especially to the broader notions of innovation in the Canadian, Danish, French, Hungarian, Slovenian, Belgian and Estonian policies, as well as in the United Kingdom. Hoidn/Kärkkäinen (2014) in their review also take a clear stance on widening the approach to innovation beyond science and technology:

> *Overall, the following three overlapping sets of skills for innovation – often referred to also as the "21st century" skills – can now be considered: •*
>
> - *Technical skills including disciplinary know-what and know-how. Innovative or creative people often require specialist skills in their field – both in terms of knowledge and methods.*
>
> - *Thinking and creativity skills such as curiosity, critical thinking, problem solving and making connections. For example, creativity is generally seen to be an important source of innovation, whereas innovating often consists of connecting seemingly unrelated ideas also from different disciplines. Innovation tends to also require open-mindedness and critical questioning well established ideas or practices.*
>
> - *Social and behavioural skills such as interest, engagement, self-directed learning, self-confidence, organisation, communication, (cross-cultural) collaboration, teamwork and leadership. For example, entrepreneurial competences such as self-confidence are important for initiating and carrying through an innovative project, as is the ability to plan and manage projects. Innovation tends to also require communication skills, including the ability to persuade others, as well as the ability to work with others in a team and coordinate activities – nowadays, in an increasingly international context. In addition of being a desired outcome in its own right, engagement plays a crucial role on study persistence and can be seen as a proxy for learning. (Hoidn/Kärkkäinen 2014:7, emphasis original)*

While this approach to the various skills does implicitly call for a broader conception of innovation, this is not yet reflected in many national KT- or innovation policies.

3.3.2 Evidence at the Institutional level

Like education and research policies, institutional action towards innovation is mostly framed by national legislation. Thus, the interesting question is what HEIs (can) do within the given frameworks provided by national legislations. Therefore, an overview of case studies from

the University Industry Innovation Network (UIIN), collating good practice of institutional actions toward innovative collaboration with industry, is presented here.

These initiatives had very different starting points; they are funded from differing sources; some initiatives were implemented by single universities, others by regional, national or international consortia; the report covers Europe as well as both Americas (Brazil, Mexico, USA, Canada) and Japan. Most of the projects presented focused on “Collaboration in R&D” and “Entrepreneurship”, as well as on “Curriculum development” and delivery of “Lifelong learning”. Several communalities can be highlighted.

– *Regional focus*
  Most of the initiatives had a regional focus. This seems reasonable and obvious but it indicates that HEIs take a certain responsibility for their environment, which in return can make the programs and activities attractive for local business and can also encourage students to participate in these programs, since many of the programs provide work-placements and other job opportunities.

– *Student centred approach*
  *Many of the p*ositive examples of the innovative activities already fulfil, what the studies on the interrelation of education and research showed: students play a central role in these projects; they are “co-creators” of knowledge. HEIs may also “use” students as building links to business (e.g. in the CIEL project, UIIN 2014:383) which contributes to inter-sectorial mobility.

– *Backing of initiative*
  Although individual projects are carried out by individual actors, the out-reach of many of the presented initiatives was to a certain extend due to the involvement of the whole HEI, respectively secured by the backing of the initiatives by the rectors or deans. This is even more important for long-term activities, where tangible outputs cannot be expected within months but sometimes not even within the project duration.

  – *Interdisciplinarity*
  The description of many projects emphasises how academic silos are an obstacle to be overcome to make the project a success, since innovation calls for academics to think across and beyond their academic and disciplinary borders.

3.3.3 Conclusion

The innovation vertex is still rather seen as an end of the other two than as an element in the knowledge triangle. The scope of innovation is seen as a main challenge here. Some countries have already taken a concept of innovation that exceeds the narrow S&T concept.

Examples at the level of HEIs also show a broader regional involvement, student centred approaches and moves towards interdisciplinarity.

3.4 Policies at the level of three-way interrelations in the KT

The three-way perspective on policies concerning education, research and innovation is a recent phenomenon, mainly from the last decade, that is strongly confined to the EU.[37] We have indicated from our research review that very few publications in academic research directly address the knowledge triangle. An analysis of the EU policy (Hervas Soriano/Mulatero 2010, abstract) argues that the Lisbon 2000 strategy has "put a strong emphasis on progress in the research, education and innovation areas. The links between these policy domains did not receive the same attention." Only the 'Europe 2020' agenda (EU Commission 2010) "relies on a more integrated research and innovation policy, strongly connected with key elements of education and training"; but the official European policy documents do not use the expression of the KT (EU 2010, 2006). Maassen/Stensaker (2011) have analysed the KT in a broader perspective and pointed on the one hand to the substantial broadening of policies during the 2000s, and to the potential conflicts between the main policy logics in education (standardisation), research (concentration) and innovation (use) on the other hand. The drive towards standardisation and accreditation through quality policies in teaching might produce tensions with the needed renewal and creativity in innovation. The concentration of (basic) research in few (strong) institutions drives towards various form of separation between research and teaching, within HEIs between teaching staff and researchers, or at the system level between research and teaching universities (e.g., England). They point even to contradictions between concentration of research and the creation of external linkages for innovation.

A closer look at the national policies shows that the triangle is only touched to a very small degree in the existing strategies. The remaining section analyses KT policies according to the analytical framework.

3.4.1 Overview of research and innovation policies

The following overview presents and analyses policies implemented on the national level. This section draws mainly from on material from the European Research Area, ERAWATCH system which covers not only the EU but also associated and third countries (so all OECD countries are covered).[38]

[37] We have shown above the different meanings given to the KT in different sectors of European policies. The OECD also gives the triangle sometimes different meanings, e.g., in the OECD Higher Education Programme (2014) the triangle is constructed from the vertices of (i) higher education institutions, (ii) governments, (iii) higher education stakeholders, see http://www.oecd.org/edu/imhe/About-IMHE-2014-Web-EN.pdf

[38] http://erawatch.jrc.ec.europa.eu/

Differentiating or unifying HE systems

The policies represented do hardly stress differences among HEIs. Although most countries know some kind of differentiation of HEIs, these are not addressed in the formulated policies. Thus, there is no conclusion to be drawn, whether the policies in place are fostering differentiation or are unifying the respective HE systems. Mostly they take the current structures as given.

Broad or narrow definition of Innovation

Most of the policies or policy strategies found refer more or less explicitly to a narrow concept of innovation in S&T only. Thus, the exceptions are more worth being noted, which we have identified in a greater degree in 8 countries (Canada, Denmark, France, Hungary, Netherlands, Slovenia, and the United Kingdom; Estonia and Belgium show a slightly wider conception of innovation.

The broader conceptions of innovation mostly include – in different distributions and with different focus – policies in the following fields or sectors: health prevention, the environment and the green economy, services, welfare, and social innovation. However all countries see the core areas in science and technology related innovation.

Box: Countries and areas of broader innovation

Canada: health technology and prevention
Denmark: green and welfare areas
France: environment, social relations and health
Hungary: open, pre-competitive and social innovation
Netherlands: societal challenges and sustainability
Slovenia: sustainable social development
United Kingdom: broader innovation platforms
Estonia: creative industries, awareness
Belgium: services

Exogenous or endogenous policies

The national policies can be grouped into three clusters, with a group of 15 countries[39] whose policies address mainly at the HEIs (endogenous), encouraging them to take action towards improving the linkage between their research activities and innovation. Another

[39] Endogenous policies focusing on HEIs: Canada, Denmark, France, Iceland, Ireland, Japan, Luxembourg, Mexico, New Zealand, Poland, Portugal, Slovak Republic, Spain, Sweden, and Switzerland.

group of 14 countries[40] show a mixture of endogenous and exogenous measures to strengthen the ties between research and innovation, and a smaller third group of 6 countries[41] are calling upon business to advance collaboration with academia (exogenous).

However, hardly any of the national policies pay attention to education as the third vertex of the triangle, so in the majority of countries hardly any comprehensive KT policy can be found. If education is explicitly covered, this is mostly through the implementation of entrepreneurship courses at universities. Notable exceptions, who pay more attention to education are Canada, Greece, Iceland, Mexico and the Netherlands, whereby mostly programmes of education for research are mentioned.

Whilst innovation is often associated with large companies, most of the policies found on national level rather emphasise the collaboration with small and medium enterprises (SME). In 13 out of 34 OECD countries SMEs are explicitly addressed as prior partners for HEIs for collaborations (regardless of the character of KT policies). This indicates a regional orientation of KT policies.

To some extent we can also identify, whether the set of measures undertaken can be understood as (more) comprehensive and integrated or as (more) fragmented, consisting of single measures only. In 6 countries (Denmark, Korea, Norway, Poland, Turkey and the United Kingdom) we find quite comprehensive and integrated concepts of KT policies. In this group, 5 countries also show an integrated/mixed approach to innovation policies, with only Poland relying endogenously on HEIs/researchers mainly as driving actors for innovation. In a bigger group of 14 countries,[42] policies can be considered as rather comprehensive. In the remaining group of 13 countries[43] policies can be considered more or less fragmented or one-dimensionally focused on certain aspects.

Endogenous approach

Typical measures undertaken in countries with endogenously orientated policies are the creation of technology transfer offices (TTOs) or similar agencies at the universities fostering knowledge transfer. These TTOs do not only commercialise final results of research undertaken but also link early stage research to possible interested parties. Other measures in this regard are the establishment of “innovation campuses” (e.g. France), “incubators and science parks” (e.g. Iceland, Poland) or “business innovation centres” (Ireland) and similar

[40] Mixed endogenous and exogenous approach: Austria, Chile, Denmark, Estonia, Germany, Greece, Hungary, Israel, Korea, Netherlands, Norway, Turkey, United Kingdom and United States.

[41] Exogenous policies: Australia, Belgium, Czech Republic, Finland, Italy, and Slovenia.

[42] France, Germany, Hungary, Iceland, Ireland, Israel, Italy, Luxembourg, Mexico, Netherlands, New Zealand, Slovak Republic, Sweden, Switzerland.

[43] *Exogenous*: Australia, Belgium, Slovenia; *mixed*: Chile, Estonia; *endogenous*: Austria, Canada, Czech Republic, Finland, Greece, Japan, Portugal, Spain; the US innovation/KT-policies could not be categorised in this scheme, since the focus is on national policies only and the state level could not be considered.

institutional settings, which should facilitate knowledge transfer from university researchers to business outside the academia.

A slightly different approach is the implementation of venture laboratories at HEIs (e.g. Japan). These facilities are designed to advance the funding of university start-ups and campus companies. However, in recent years the number of university start-ups declined in Japan, which may be understood as a result of the difficult overall economic climate. A more constraint orientated means to foster academic entrepreneurship can be found e.g. in Luxembourg, where performance contracts between HEIs and authorities stipulate numbers of patents to be applied or a sum of funds to be gained from public-private partnerships. Some countries (e.g. New Zealand) provide researchers with monetary incentives to collaborate with business partners.

The endogenous measures taken are well known, and mostly address the '*developmental periphery'* of the entrepreneurial university.

Mixed approaches

Policies applying a mixed approach of addressing both business and HEIs do not simply consist of a mixture of endogenous and exogenous measures but of integrated programs. A main difference in these programs is whether they encourage corporations to collaborate with HEIs as institutions, or with individual researchers/academics. E.g., the Austrian innovation policy's objective is an overall transformation toward a more knowledge intensive economy. Therefore, innovative industries should be supported by encouraging companies to innovate and approach university researchers to collaborate. At the same time entrepreneurship is promoted in HEIs. Similar policies are found in Denmark, Estonia or Germany. Other approaches, like Chile's, are twofold by on the one hand promoting individual mobility of researchers between academia and business, and on the other hand funding joint consortia of universities and corporations. Comparable measures were implemented in Greece and Hungary. Turkey also promotes inter-sectorial mobility of researchers by providing financial incentives for researchers to work in (private) companies in techno parks, which are located at the universities. Thus, researchers may move from academia to business without leaving the university (neither ideally nor physically). Another action found in this mixed approach is the creation of incubation centres at institutional, regional or state (US) level. These programs often go hand in hand with policies facilitating the commercialisation of research outputs in a way that the HEIs (not just the individual researchers) can profit from (like the influential Bayh-Dole Act in the US).

While most of the mentioned initiatives are operating within a narrow innovation concept, the integrated approach of endogenous and exogenous policies is also feasible for initiatives going beyond that. An example for this is the creation of "innovation platforms" in the United Kingdom, trying to bring together researchers, SMEs and other stakeholders to deal with

different kinds of societal challenges. In Korea, policies aim at the creation of an inviting and welcoming atmosphere for business at HEIs. Since the 1990ies the government promoted the creation of business incubating centres at HEIs, which supply SMEs with counselling; including efforts for facilitating networking between SMEs among each other and with HEIs and researchers.

We see some tendency in the countries with mixed policies also more comprehensive approaches; however, the measures taken are to a high degree similar to those in the endogenous countries.

Exogenous approach

The minority of countries in the OECD rely on exogenous KT policies. Policies found in these countries promote research activities in corporations and industries. These policies use incentives for companies to invest in R&D such as direct funding of researchers (e.g. Australia), tax incentives and other measures to increase R&D capacities (e.g. Belgium, Italy, Czech Republic) or grants and loans for start-ups (e.g. Finland).

Mode of Third Mission

Most of the policies at national level aim at fostering entrepreneurship in HEIs and/or among individual researchers. Insofar, they interpret the third mission of HEIs mainly in terms of the "entrepreneurial university". This holds especially true for examples such as Luxembourg where patents and licenses are part of the performance agreements between state authorities and the university.

In some countries attempts of strengthening the relationship of HEIs to their regional environment is explicitly stressed (e.g., Belgium, Denmark, Korea, Poland or Switzerland); in addition the explicit support of collaboration with SMEs (13 countries) may be understood as a reference to a regional innovation system approach (RIS).

However, it is peculiar that the other two approaches, the "engaged university" and "mode-2 knowledge production" can hardly be found to be objectives of policies.

3.5 Concluding analysis of policies

For the analysis of institutional evidence on KT activities, we focused on good practice examples (education, innovation), and a survey that highlights barriers and drivers for cooperation (research). Although these studies take different approaches and perspectives, we can get a conclusive overall picture. Overall, most policies have not reached a level of considering the three-way relationships in the triangle, rather single vertices or two-way

relationships are addressed. To sum up, main ingredients of successful KT policies on institutional level seem to be:

Regional embedding of the KT activities

In times of globalising economies and markets, this approach may seem a bit backward-looking, but one has to keep in mind, that there are a lot of specialised SMEs who may be global market leaders, operating worldwide in their specific niche. This attitude of “thinking global, acting local” applies even more for knowledge intensive businesses.

Students involvement

As outlined in the beginning, the first mission of HEIs was always education – and it always will be. According to academics asked about the main beneficiaries of their cooperation with business, they mention the students. Since students are at the heart of HEIs it seems obvious to involve them actively in KT processes, be it research-teaching-nexus approaches or innovation activities “using” students for bridging between sectors.

Long-term perspectives

HEIs do not change over-night, nor do academic cultures. Implementation processes of the KT need time and a long-term perspective. The same applies for KT activities, especially the fact, that relational qualities are more valued than business qualities in facilitating cooperation shows, that KT activities need sustainable partnerships, within and outside the HEI.

Career development for academics

Academia has its own procedures of adding to reputation and promoting researchers. To encourage academics to get more engaged with the KT, these activities need more visibility outside but especially within academia and have to be considered as another criterion besides research excellence for the evaluation and promotion of researchers.

Interdisciplinarity

Innovative actions call for interdisciplinarity. But like bridges need solid riverbanks, interdisciplinarity needs excellent researchers from the respective disciplines. Disciplinary know-what and know-how are of great importance for innovative action. Thus, an atmosphere of partnership on equal foot across scientific boarders and with business partners seems to be crucial for realising interdisciplinary work.

Valuing of KT activities

The initial implementation of KT activities is time and money consuming. While financial resources are an issue of funding and supply of resources, the aspect of time resources is also related to the career development issue. Further, this point relates to the accreditation of KT activities for students already.

Integrating the KT into HEIs' strategies

This is by far the most ambitious effort, but examples like the EPFL (see 3.1.2) show the benefits of this approach, for the region, the students and the HEI. Last but not least, this integration leads to more responsiveness of HEIs to their regional environment at all vertices.

4. Identification of gaps, potential areas for follow up work and policy questions

We have tried to understand the existing policies according to the knowledge triangle, and basically we see two rather disturbing gaps. The first is that the KT in a somehow tangible way hardly exists. We can find it as a kind of weak policy device at European level, however, it is not or hardly mentioned in more formal policy documents, and we can also find different meanings of the concept. The literature search also has shown that there is virtually no academic research available that directly would address the KT. The tangible meaning of the KT can be found in its vertices, the triad of education, research and innovation. This leads to the second gap, the question, whether it is a good idea to bring the three topics into the image of a triangle. The basic idea is clear, the three elements are interrelated, and should be tackled in an integrated way. The problem with the triangle is its chronic instability (which was also one of the stating points of the triple helix). Higher education struggles always with the tension between its missions of research and teaching, and from this point of view a third mission is added. From the other side the innovators or entrepreneurs struggle with the search for solutions or ideas which they might find from research, and at a closer view the relationship between research and innovation is also quite complex and problematic. Now education should be brought into a relationship with them, too. The form of the triangle seems to make these relationships rather more complicated than understandable. We have somehow tried to solve this through a hierarchical relationship of one-way, two-way, and the three-way perspective. However, this seems to reproduce all discourses which have been already there, and thus displays the complexity of the relationships involved. It seems, that the triangle seems to break this complexity, but at a closer look, it does not, it seems only so.

In terms of policies an aspired turn from differentiation to integration was identified as a basic challenge. Whereas solutions during the last decades emerged via a differentiation of HE within institutions and by new types evolving, the KT policy should reverse this trend and find ways to integrate. If this is true, we can expect difficulties in the adoption of this turn. The analysis of existing policies shows that kinds of three-way policies have hardly been developed so far. Policies still struggle with unresolved problems at the vertices, and with the tensions in the two-way relationships.

Another gap exists with the systematic location of the triangle and the tension between the institutional level and the aggregate level. Policy can try to develop the triangle at the level of HEIs, or it can try to develop it at a more aggregate system level, with the institutions contributing from their diverse positions. In both cases the diversity of institutions and the variation of their structuring must be considered. At the institution level the KT will look very different at a global research university, as compared to a polytechnic in a moderately remote small town. It could make sense that an institutional KT policy is only possible at the

level of a large and excellent research university (some of the considered studies have taken this kind of HEI as cases). Then the contribution of the diverse to an aggregate (more virtual) KT would be the task. To device a policy of this kind, a systemic analysis of HEI networks, and a respective positioning of the institutions would be necessary. This would require a very high degree of planning, which will probably not be acceptable.

The next gap concerns the question, to which degree, and by which instruments the HEIs can be steered, if they are autonomous institutions. This would require to install the three missions, and to set regulations, funding mechanisms, incentives and sanctions, etc. according to the performance. As far as we know, the HE systems are governed due to a high degree of hybridity. Steering is only possible very roughly, and confronted with various forms and degrees of resistance. As we know, there exist certain mechanisms of resistance exactly against methods of position HEIs in a certain structure (typical: academic drift, resistance against the differentiation according to the Bologna structure).

Finally, it is not clear so far, to which degree innovation has been already established as a third mission in HEIs, and how the shape and configuration of the third mission looks like. The analysis of national policies shows at this level the most activity, to improve the 'developmental periphery' whereby the conception of innovation is mostly a narrow one, related to economic S&T innovation. Simple conceptions of the entrepreneurial university are the main governance device, whereby the 'academic heartland' as the area of the more traditional perceptions of universities is a contested terrain.

The leading question of this study is how policies can contribute to the improvement of the ties between education, research and innovation. Given the mentioned gaps, the task appears quite difficult, as each of the missions, and their interrelations include much dispute at the research as well as at the policy level. Comparing the case studies of good practice, it was hard to retrieve national policies in institutional actions. Conceptual clarifications, and the creation of a common view of the core concepts, in particular a reconciliation of the different meanings of innovation and of the KT, and some common understanding how far KT policies have been already started, should be included in the next steps.

Further, the next steps should focus on case studies of good practice, putting special focus on the way national policies (can) contribute to the implementation of KT policies on the institutional level.

Guiding questions for institutional case studies:

- Exogenous or endogenous process

What was the initial reason to rethink third mission and innovation activities? Is this perceived a bottom-up or a top-down process? What influence did policies (international,

national, regional) have? Do HEI representatives and academics alike consider this process exogenous or endogenous?

- Differentiating or unifying HE systems

How do different types of HEIs respond to the third mission and the KT? (How) does competitive funding for the different missions of HEIs affect the relationship of HEIs and the whole HE system? Do national KT policies foster or hinder cooperation of HEIs with each other?

- Broad or narrow definition of Innovation

What innovation concepts are deployed? How do HEIs respond to innovation concepts of national KT policies? Do/can they champion e.g. a broader innovation concept "against" a pure technology understanding of innovation on national policy level?

- Level of implementation, level of action

Who is addressed by whose KT policies? Do different political authorities address different actors in the HEIs? How is information distributed in the HEI? How autonomously can academics respond to offers for cooperation?

- Mode of Third Mission

How can the implementation of the KT understood in terms of the different concepts of the third mission?

The findings should be contrasted with an in-depth analysis of the respective policies, the individual HEI deals with, regarding the same five topics. The envisaged outcome would be a two-level typology, connecting the national policies to a typology of KT activities undertaken by HEIs. Since we found very little comprehensive KT policies on national level, HEI representatives and academics should be further asked, which policies (funding schemes, legal regulations, etc.) would foster their individually undertaken KT efforts.

There are over 7,000 HEIs in the OECD. A selection of case studies for the second project phase is therefore a difficult undertaking. However, the studies presented in sections 3.1.2 and 3.3.2 may serve as a pre-selection, since they collate KT activities on education or innovation. Table 1 summarises the countries with more extensive policies, which might serve as a preliminary reservoir for case studies. These case studies could be further exploited by examining the effect of these activities on the other vertices in more detail. However, a prerequisite of this selection are an adequate representation of the different types of HEIs (e.g. the good practice case studies on education include no universities of applied sciences or colleges) as well as a representation of all OECD countries or at least of regional clusters (Europe, Anglo- and Latin-America, Japan/Korea, Australia/New Zealand).

Table 1: Countries with indications for more intense policies

Education			**Innovation**		**Flagship Institutions**
Included in policy	Programme	Teaching-Research Nexus	Broader concept	Comprehensive integratedl	
		Australia			
			Belgium		
Canada	CREATE		Canada		
			Denmark	Denmark	Aarhus University, Denmark
			Estonia		
			France		Université Joseph Fourier, Grenoble, France
Germany	High Tech Strategy				Karlsruhe Institute of Technology, Germany
			Hungary		
Iceland	Institute Research Centers				
				Korea	
Mexico	Postgrad.Industry				
Netherlands	Quality in Diversity	Netherlands			
		New Zealand			
				Norway	
				Poland	
Portugal	Strat.Progr.Entrpreneurship				
			Slovenia		
				Turkey	
	CETL		United Kingdom	United Kinddom	University College London, UK,
					University of the Arts London, UK
					Aalto University, Finland
					Zürcher Hochschule der Künste, Switzerland,
					École Polytechnique Fédérale de Lausanne, Switzerland
					Mondragon University, Spain
					Umea University, Sweden,
					Chalmers University of Technology, Sweden
					University of Trento, Italy,

5. Tabular overview of national KT-policies

Australia	In recent years, there have been some innovation initiatives that have had impacts on researchers and research organisations as well. These programmes have provided training in commercialisation for postgraduate research students, provided assistance to entrepreneurs, promoted collaboration between businesses and the research sector, provided funding to partly cover salaries for researchers in SMEs and support for SMEs with high-growth potential. However, there has been very little policy on national level targeted at commercialisation infrastructure, such as incubators. To the extent that there has been support for such initiatives it has either been one-off or has been from State governments. Education policy is not mentioned as key component of innovation policy in Australia.
Austria	In Austria, research and innovation policies are closely interlinked, since in Austrian innovation policy, research is explicitly addressed as a key part of innovation. However, educational policy has not been fully integrated in the knowledge triangle so far, which is described as challenge to be tackled throughout the next couple of years. During the past years, specific measures and programmes have been implemented to stimulate entrepreneurship at Austria's universities. Austrian ministries pursue innovation policies that address the business sector and potential entrepreneurs among university researchers. A main objective of Austrian innovation policy is structural change towards a greater share of high-tech industries and innovative companies. Therefore, corporate venturing is a subject of policy measures. The Austrian provinces have initiated a range of services and funding programmes that aim to stimulate entrepreneurship. However, these measures are of small scale in terms of budget and geographical range.
Belgium	In Belgium, education, research and innovation policy terrains are not congruent: Education policy is within the responsibilities of the language communities whereas research and innovation policies are the responsibilities of the Belgian regions. Innovation policy in general is administered in an implicit manner or as part of a research-innovation policy mix. Over the last years, efforts on the federal level have been made to foster scientific and industrial research trough financal incentives (particularly through tax reduction schemes for R&D activities). Funding initiatives both on national and regional level remain focused on technological innovation. However, there is a recent emphasis to foster other forms of non-technological innovation, e.g. in the field of services.
Canada	For over 20 years, the Canadian government and some provinces have funded Centres of Excellence that foster partnerships of private, academic and public sector organisations to focus on specific areas of economic or social importance. One example for such a centre is the “Canadian Stroke Network” that develops programmes to reduce the risk of stroke and improve recovery from stroke. There are also centres that are focused on commercialisation of early stage research knowledge. Alongside innovation and research policy, education policy is included as a key component of the policy mix. The Canadian “Collaborative Research and Training Experience Programme” is designed to build the capacity of universities to deliver entrepreneurship training and improve the business related skills of science and engineering graduates.
Chile	In Chile, interaction between key players within the national innovation system has been considered week. As response to lacking cooperation between universities and the private sector and inter-sectoral mobility, several technological consortiums between companies and universities have been provided federal funding. In addition, the “Programme to Attract International Centres of Excellence” has been established. The programme funds international research organisations that set up an entity in Chile and generate research in collaboration with Chilean players (especially universities). Education policy is not mentioned as key component of innovation policy in Chile.

Czech Republic	In the Czech Republic, knowledge triangle policies are mainly pursued through the "Operational Progamme Enterprise and Innovation" (time period: 2007-2013). The development of innovation clusters and support of entrepreneurship are still at their initial stage. Therefore, the programme aims to increase the capacity of companies for R&D and innovation, to create infrastructure for cooperation between companies, research and training institutions and to establish technology transfer centres. Another focus of the programme is the support of commercial exploitation of research results. Education policy is not mentioned as key component of innovation policy in the Czech Republic .
Denmark	In Denmark, a wide variety of knowledge triangle policies has been implemented throughout the last decade. Research and innovation policies are closely interlinked and include a large number of measures that aim at stimulating public-private partnership. Institutions such as technology transfer offices contribute to better commercialisation of research results and to cooperation between research institutions and companies. Various grant programmes support Danish enterprises with the aim of fostering an innovative economy, e.g. a Business Innovation Fund (2010-2012) with the aim of supporting innovation and market maturity within the green and welfare areas, or its successor programme, the Market Development Fund that helps firms bringing their new products to the market faster. There are a range of measures at the regional level that aim at strengthening knowledge based growth and development in the regions outside of the larger cities (e.g. Regional Technology Centres). In 2010, a new initiative for the strengthening of entrepreneurial universities was launched. One of the priorities of this initiative is the promotion of entrepreneurial training at universities in Denmark. This approach shows that education policy is included in the policy mix alongside innovation and research.
Estonia	In Estonia, there are various measures that support business start-ups. The policy effort is focused mainly on the promotion of entrepreneurship in general, not specifically in R&D-intensive sectors. However, throughout the last decade there have been measures implemented that support local companies to shift to R&D intensive manufacturing via technological modernisation, such as the "Technology Competence Centres Programme" or "HEIs-business collaboration development". Since 2001, a programme has been conducted with the objective of supporting entrepreneurship in universities. Education policy is not mentioned as key component of innovation policy in Estonia.
Finland	In Finland, there is a wide range of support programmes that aim at supporting innovative business start-ups and SMEs through grants, loans and seed financing. There are targeted measures designed to support innovations that have complementary impacts on research activities in Finland. However, Finnish innovation policy does not explicitly refer to education policies.
France	Innovation policy in France aims at implementing open innovation, involving public research and fostering knowledge transfer between the public and private sector. There is a strong link between research and innovation policies. French research and innovation policies aim at the creation of SME-public research joint labs, improved commercialisation of research results and sustainable private-public partnership. The Competitiveness Cluster policy (first established in 2005) gathers companies, training centres and public and private research organisations around innovative collaborative projects. Each cluster is specialised in scientific and technological fields. Alongside the competitive cluster policy, there are other measures that foster technological innovation campuses, bringing together educational institutions, public laboratories and private research at the same location. Education policy is not mentioned as key component of innovation policy in Chile.

Germany	Innovation and research policies are closely interlinked in Germany. Thus, most support programmes provide funding for both research performed in research institutes and innovation and technical development performed in enterprises. Most R&D support policies explicitly target SMEs since they are considered essential drivers of innovation. In 2010, the "High-tech Strategy 2020" has been introduced. It includes some measures within education policy but the main focus is placed on innovation and research policies. The strategy is aimed at improving the coordination of R&D and innovation policies as well as a more effective exploitation of research results by enterprises. One example for a corresponding initiative is the "High-tech Start-up Fund" which was established in 2005 and funds innovative business start-ups. Another measure, the "EXIST programme" funds research-based start-up projects and aims to improve the framework conditions for entrepreneurship at universities. Another central programme is the "German Federation of Industrial Research Associations" that promotes applied R&D in and for the benefit of SMEs.
Greece	Innovation policy is considered the focus of the Greek knowledge triangle policy. The economic importance of SMEs is stressed within innovation policy. Funding programmes are aimed at supporting SMEs, commercialisation of research results, eco-innovation in industry, development of clusters and support of innovative entrepreneurship. A number of science and technology parks has been established in the last ten years. The Ministry of Education and Religion is encouraging the introduction of entrepreneurship courses in university curricula. In addition, career offices are established at universities and polytechnics that provide career development counselling activities and foster entrepreneurship.
Hungary	Innovation and research policies are closely interlinked in Hungary. However, education policy is not mentioned as key component of the Hungarian knowledge triangle policy. Several measures have been implemented to foster industry-academia cooperation, to fund joint research projects, to establish research and knowledge centres, to provide support for employing researchers and to facilitate research mobility. In order to institutionalise knowledge transfer in Hungary, university knowledge transfer offices have been established at major HEIs. However, these knowledge transfer organisations remain generally weak. This is why the "National Research-development and Innovation Strategy 2013-2020" (approved in July 2013) specifically addresses the support of efficient knowledge and technology transfer collaborations.
Iceland	In Iceland, several innovation policy measures are aimed at fostering cooperation between universities and the private sector, such as the "Innovation Centre" or the University of Iceland Science Park. The "Technical Innovation Fund" provides project financing in support of technological innovation to companies, research organisations and universities, as well as support to spin-off ventures. Seven incubation centres offer support to SMEs and start-up companies. The University of Iceland's Institute of Research Centres supports the University's collaboration with local authorities, businesses and individuals in rural areas. The institute's objectives are to strengthen the University's ties to local enterprises and daily life in rural areas, to provide facilities for research projects dealing with local environmental and societal conditions, to provide facilities for students' field work and to increase access to research based education in rural areas. This approach shows that education policy explicitly is included in the policy mix alongside innovation and research.
Ireland	It appears that innovation and research policies are closely interlinked in Ireland. However, education policy is not mentioned as key component of the knowledge triangle policy. Several measures have been implemented to support high technology spin-off companies from the higher education sector (e.g. training and other support to entrepreneurs to assist them in developing the skills required to establish and run their own businesses). Other measures are aimed at helping the private sector to access research results and at improving access by research centres to research infrastructure of HEIs. In 2012, a central technology transfer office has been established. Additionally, 20 business innovation centres are established at HEIs.

Israel	In Israel, the government's knowledge triangle policies specifically are focused on areas that are not covered by other institutions or private business. For instance, the incubator programme supports technological entrepreneurs who cannot apply directly to the Israeli Venture Capital firms that specialise in seed financing. As a result incubators tend to specialise more in medical devices and biotech fields since these are areas Venture Capital firms usually do not fund in the seed stage. There are other funding programmes, such as the Nofar programme that is intended to increase innovation in Israeli industry in biotechnology and nanotechnology, by encouraging technology transfers from academia to industry. In addition, all seven Israeli research universities have technology transfer companies that specialise in commercialising research results. Education policy is not mentioned as key component of innovation policy in Israel.
Italy	It appears that innovation and research policies are closely interlinked in Italy. However, education policy is not mentioned as key component of the knowledge triangle policy. Several measures have been implemented to promote public-private partnership to foster innovation since lacking knowledge transfer from research towards business is described as weakness in Italian research and innovation policy. Since 2011, efforts have been made to increase funding for research and innovation, especially regarding SMEs, and to reform firms' incentives for R&D activities. Industrial Innovation projects have been launched as well as the introduction of tax benefits for businesses financing university projects, businesses in public-private partnerships or businesses employing highly qualified researchers.
Japan	In Japan, there is no explicit knowledge triangle policy concept employed. However, Japanese policymakers emphasise a triangle between industry, government and universities which focuses on entrepreneurship education. The number of universities that have implemented entrepreneurship courses and programmes has been increasing gradually since 2001. Since the mid 1990s, numerous venture laboratories have been established at university locations as well as an increasing number of start-up companies. However, the number of firms established each year has declined over recent years. Alongside other reasons for this tendency it is suggested that this is due to a lacking focus on managerial development skills that are needed in the time after establishing a company. Research policy is not mentioned as key component of innovation policy in Japan.
Korea	It appears that innovation and research policies are closely interlinked in the Republic of Korea. However, education policy is not mentioned as a key component of the knowledge triangle policy. Since the 1990s, the Korean government has supported the establishment of business incubating centres at universities as well as research institutes. This programme provides SMEs with business spaces and counseling. In addition, the establishment of business research labs in universities and public research institutes has been supported as well. There are several measures designed to encourage networking amongst SMEs, universities and research institutes. Another important measure is the support of the creation of innovation clusters with the objective of promoting science and technology innovation. In order to promote balanced economic growth that will make a contribution to tackling regional disparities in the nation, efforts have been made to establish a regional innovation system, especially through supporting regional clusters.
Luxembourg	It appears that innovation and research policies are closely interlinked in Luxembourg. However, education policy is not mentioned as key component of the knowledge triangle policy. The performance contracts between the Ministry of Higher Education and Research and the University and Luxembourg's other public research institutions is defined as integral component of the knowledge triangle policy. The performance contracts stipulate goals for numbers of patents and spin-offs to be realised as well as income to come from public-private partnerships. In order to achieve these goals, the government has supported several initiatives such as incubators to support innovative start-ups, promotion of public-private partnerships, information for entrepreneurs and providing support for private R&D.

Mexico	In Mexico, several measures haven been implemented that are aimed at strengthening public-private partnership, increasing commercialisation of research results, fostering entrepreneurship and increasing inter-sectoral mobility between academia and industry. Examples for these programmes are the establishment of intermediary institutions and knowledge transfer units (first one established in 2011) that promote synergies between academia and industry by linking research results and businesses together. Another policy measure is the participation of enterprises in the development of academic programmes at business schools focusing on the use of technology. These short-term academic programmes that are created in cooperation with businesses show that education is considered a key component of knowledge triangle policy alongside innovation and research.
Netherlands	Education policy is described as integral component of the Dutch knowledge triangle policy, in particular through the “Quality in Diversity” strategic agenda which has a long-term perspective on higher education, research and science. The agenda includes measures to increase public funding for education, enhance quality in higher education through funding initiatives, reinforce relevance of programmes regarding labour market demands and develop focus areas in research. Complementary to the agenda, the “Enterprise policy” aims at cooperation between knowledge institutes, businesses and public authorities. This approach gives special attention to challenges facing society in the near future, including issues related to sustainability. There are several measures that support research and innovation and knowledge transfer. In addition, a SME innovation fund was introduced in 2012 as financial support measure for innovative companies. In the Netherlands, innovation and research as well as education are seen as important components of the knowledge triangle. However, it appears that the link between innovation and research policies is considerably stronger than the link between innovation and education policies.
New Zealand	A main focus of knowledge triangle policy in New Zealand is to provide public-sector researchers with funds to work with industry partners. Another important factor is entrepreneurship education that is provided at universities (mostly as an elective option for students in various programmes). However, there isn’t any significant effort in terms of nation-wide coordination of entrepreneurship education. The spillover effect from entrepreneurship education to promote science-based entrepreneurship is not well developed. New Zealand has two technology parks and about 14 business incubators, most of which are associated with a university. Recent efforts are aimed at improving the effectiveness and efficiency of commercialisation technology transfer offices that are predominantly based at universities.
Norway	In the last decade, Norway has seen an extensive effort to implement policy measures in order to strengthening the links between industry and the knowledge infrastructure. Among policymakers there has been a growing interest in fostering individuals’ creative and innovative abilities for future economic growth and value creation in the country. Major instruments of the innovation and research policy are centres for research-based innovation and the Norwegian "Centres of Expertise programme". Since 2003, HEIs have been setting up technology transfer offices using science parks and incubators to link up with industry. Other measures are aimed at increased research activities in companies and strengthened knowledge exchange between industry and academia. Alongside innovation and research policy, education policy is included as a key component of the policy mix. Since 2004, entrepreneurship in education and training has been a prioritised area in Norwegian educational policy and is offered at some schools and half of all HEIs. An Action Plan from 2012 stipulates to further strengthen the quality and the scope of entrepreneurship education and training at all levels.

Poland	It appears that innovation and research policies are closely interlinked in Poland. However, education policy is not mentioned as key component of the knowledge triangle policy. Following relevant policies and instruments have been implemented in order to support innovation and having complementary impacts on researchers and research activities: Policies to stimulate incubators/science parks at universities/research centres, policies to support industrial liaison offices at universities/research centres, policies to support entrepreneurship in universities, policies to support corporate venturing and mobility programmes allowing researchers to conduct innovation projects in companies. The latter include multiple regional projects offering researchers the opportunity to work temporarily at companies on innovative projects. In addition, public universities were obliged to introduce intellectual property management regulations and establish special purpose companies dealing with transfer of university technologies to industry and fostering academic spin-offs. However, in spite of a wide range of publicly funded programs, the actual results of academic technology transfer and industry-science co-operation remain insufficient. As reaction to this challenge a policy shift has taken place recently, i.e. the position of HEIs regarding intellectual property rights has been weakened while the researchers' position has been strengthened.
Portugal	During the last decade, several measures have been established with the aim of bridging the policy gap between the two areas of innovation and research. These measures aim at technology and knowledge transfer, interaction between innovation and research, creation of innovation clusters and more efficient exploitation of research results. However, in spite of some initiatives to stimulate policy interaction and coordination, there is no fully integrated policy approach to the knowledge triangle so far. The "Strategic Programme for Entrepreneurship and Innovation" (December 2012) therefore includes several measures which aim at improving the connections between the sides of the triangle, e.g. through encouraging the economic exploitation of scientific knowledge, supporting patent registration and hosting initiatives to encourage entrepreneurship. Alongside innovation and research policy measures, the strategic programme includes education policy as well (e.g. promoting the experimental drive in basic and secondary education and education for entrepreneurship).
Slovak Republic	Within Slovak knowledge triangle policy the focus lies with innovation policies dominated by the Innovation Strategy 2007-2015, with complementary effects on R&D. However, education policy is not mentioned as key component of the knowledge triangle policy. Innovation policy focuses on the support of research activities at HEIs, public research organisations, NPOs and research cooperation between the private sector and academic institutions. For this purpose, "Centers of Excellence", "Research and Development Centres" and science parks have been established and supported. Another measure has been the support of research and non-research infrastructure at HEIs. For the period 2014-2020, the "Smart Specialisation Strategy" stipulates a number of measures aimed at promoting entrepreneurship at universities and fostering science parks.
Slovenia	Innovation policy has been an issue of growing political attention during the last years in Slovenia. The context of this development has been a relatively influential public R&D sector, increasing presence of business as the key investor in R&D and innovation and a search for optimal governance of innovation policy. A strong link between innovation and research policies is emphasised. However, education policy is not mentioned as a key component of the knowledge triangle policy. Slovenia's R&D and innovation policy documents were adopted in 2005 and 2006 and are aimed at securing the country's long-term sustainable economic and social development. However, Slovenia has experienced several implementation problems of R&D and innovation measures due to insufficient coordination of the policy measures and an inefficient administrative system of R&D and innovation support. So far, the policy has not been sufficiently integrated to provide synergy results.
Spain	The main focus of Spain's innovation policy lies with support of public-private cooperation in R&D and innovation since the level of public-private collaboration has been considered low. Spain's innovation policy has included measures to improve the mechanisms of knowledge transfer, establishing knowledge transfer offices and technology parks, promoting clusters of innovation and supporting new technology based companies. Public funds for innovation and knowledge transfer are predominantly provided through the "Business leadership programme". Education policy is not mentioned as key component of innovation policy in Spain.

Sweden	It appears that the main focus of Swedish knowledge triangle policy lies with a policy mix of innovation and research. However, education policy is not mentioned as a key component of the knowledge triangle policy. Since 2008, several “innovation offices” have been established at Swedish universities with the objective of providing support in issues such as commercialisation, patenting, knowledge exchange and encouraging innovative research. The rationale behind these innovation offices is to increase the utilisation of research results and create benefits for the society and industry. Another focus of Swedish innovation policy is to provide access to venture capital and financial support to spin-offs and innovative companies. In addition, efforts have been made to increase inter-sectoral mobility and interaction between academia and industry.
Switzerland	Innovation and research policies appear to be closely interlinked in Switzerland whereas education policy is not mentioned as key component of the knowledge triangle policy. It has been a clear policy focus in the most recent years to promote the establishment of new R&D performing firms, especially university start-ups. At national level, there are programmes that support the creation of innovative start-ups and cooperation between SMEs and start-ups and research organisations. Swiss legislation has been focusing on improving venture capital conditions and simplifying taxation. However, most initiatives have been promoted by regional actors together with universities, such as the establishment of science and technology parks.
Turkey	In Turkey, several measures haven been implemented that are aimed at increasing commercialisation of research results, fostering entrepreneurship, supporting R&D and innovation activities of SMEs and promoting the creation of technology-based companies. One example for these programmes is the establishment of "technoparks" that are created to bridge the gap between the industry and academic communities. The technoparks are located at universities or research centres, encourage the establishment of spin-off companies and foster mobility of research personnel by providing financial incentives to work with private companies located in technoparks. Another measure is support of technology incubators located at technical universities. Initiated in 1991, the measure provides support for entrepreneurs/SMEs having new technological ideas and innovations. The “Industrial Thesis Projects Support Programme” promotes university-industry interactions by co-financing research activities conducted by universities for a private sector company. However, there are no direct mobility schemes allowing Science and Engineering researchers to conduct innovation projects in firms. In 2012, the ”Entrepreneurial and Innovative University Index of Turkey” was introduced. The annually announced ranking of HEIs aims to encourage entrepreneurship and innovative activities in universities. Education policy is not mentioned as key component of innovation policy in Turkey.
United Kingdom	It appears that the main focus of knowledge triangle policy in the United Kingdom lies with a policy mix of innovation and research. However, education policy is not explicitly mentioned as a key component of the knowledge triangle policy. A comprehensive set of innovation policy measures has been developed in the UK. Evidence suggests that the range of long-standing programmes such as cluster-type measures (e.g. "Catapult Centres”, knowledge and innovation centres and research and innovation campuses) and measures with the objective of translating research results into commercial products have been successful. Most HEIs have knowledge transfer offices or similar bodies. In addition, numerous programmes focus on mobility of personnel between the science base and industry. Other policy measures aim at promoting knowledge circulation such as the “Innovation Platforms” which address societal challenges, bringing together SMEs, the knowledge base and other stakeholders.
United States	It appears that the main focus of US knowledge triangle policy at federal level lies with a policy mix of innovation and research. This policy interaction is aimed at commercialisation of the outputs of federal laboratories, entrepreneurship, encouragement of R&D intensive start-ups and support for SMEs performing R&D activities. The federal government is less active in innovation policy than state and local governments. Most of all states have implemented organisations for technology transfer, incubation and venture seed funding. Over the last decade, the federal government is considered responsible for research policy more explicitly while the support for major programmes aimed at commercialising research outputs has decreased. Education policy is not explicitly mentioned as key component of innovation policy in the United States.

Source: ERAwatch and related documents.

6. References

Altbach, Philip G.; Reisberg, Liz; Rumbley, Laura E. (2009) Trends in Global Higher Education: Tracking an Academic Revolution. A Report Prepared for the UNESCO 2009 World Conference on Higher Education. Paris: UNESCO, 2009 http://www.unesco.org/tools/fileretrieve/2844977e.pdf

Arocena, Rodrigo; Sutz, Judith (2005) Latin American Universities: From an original revolution to an uncertain transition. Higher Education 50: 573-592.

Asheim, Bjørn T.; Gertler, Meric S. (2005) The Geography of Innovation. In: Fagerberg, Jan; Mowery, David C.; Nelson, Richard R. (Hg.) The Oxford Handbook of Innovation. Oxford: Oxford University Press, pp 291–317.

Atkinson, Richard C.; Blanpied, William A. (2007) Research Universities: Core of the US Science and Technology System, Center for Studies in Higher Education, Research & Occasional Paper Series: CSHE.5.07. UC Berkeley.

Audretsch, David; Phillips, Ronny J. (2011) Entrepreneurship, State Economic Development Policy, and the Entrepreneurial University. Discussion Papers on Entrepreneurship, Growth and Public Policy 1107. Max-Planck-Institut für Ökonomik Jena. [Download unter: https://papers.econ.mpg.de/egp/discussionpapers/2007-11.pdf].

Baumeler, Carmen (2009) Entkopplung von Wissenschaft und Anwendung. Eine neo-institutionalistische Analyse der unternehmerischen Universität. Zeitschrift für Soziologie 38(1): 68-84.

bepa (2011) Empowering people, driving change: Social innovation in the European Union. Luxembourg: Publications Office of the European Union.

Berger, Suzanne (2013) Making in America. From Innovation to Market. Cambridge, MASS: MIT Press

Bilbao-Osorio, B ; Rodriguez-Pose, A. (2004) From R&D to innovation and economic growth in the EU. Growth And Change 35(4): 434-455.

Bologna Working Group on Qualifications Frameworks (2005) A Framework for Qualifications of the European Higher Education Area (February). http://www.ehea.info/Uploads/qualification/050218_QF_EHEA.pdf

Bowen, Glenn (2010) Civic Engagement in Higher Education Resources and References Center for Service Learning Western Carolina University.

Brown, George; Atkins, Madeleine (1993). Effective teaching in higher education. London: Routledge.

Calvert, Jane; Martin, Ben R. (2001) Changing conceptions of basic research? Background Document for the Workshop on Policy Relevance and Measurement of Basic Research Oslo 29-30 October 2001.

Chatterton, Paul; Goddard, John (2000) The Response of Higher Education Institutions to Regional Needs. European Journal of Education. Vol. 35, No. 4: 475-496.

Clark, Burton R. (2001) The Entrepreneurial University: New Foundations for Collegiality, Autonomy, and Achievement. Higher Education Management 13(2): 9-24.

Clark, Burton R. (1998) Creating Entrepreneurial Universities: Organizational Pathways of Transformation. Oxford: International Association of Universities and Elsevier.

Cohen; Wesley M.; Levinthal, Daniel A. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly 35(1), Special Issue: Technology, Organizations, and Innovation. (March): 128-152.

Crespi, Gustavo, Pablo D'Este, Roberto Fontana, and Aldo Geuna (2009) The impact of academic patenting on university research and its transfer. ICER Working Paper N001.09.

Czarnitzki, Dirk; Grimpez, Christoph; Tooley, Andrew A. (2014) Delay and secrecy: does industry sponsorship jeopardize disclosure of academic research. Industrial and Corporate Change, pp. 1–29

David, Paul A. (2004) Can 'Open Science' be Protected from the Evolving Scheme of IPR Protections? Journal Of Institutional And Theoretical Economics 160(1):9-34

David, Paul (2003) The Economic Logic of "Open Science" and the Balance between Private Property Rights and the Public Domain in Scientific Data and Information: A Primer. In: Julie M. Esanu and Paul F. Uhlir, Ed. The Role of Scientific and Technical Data and Information in the Public Domain: Proceedings of a Symposium Washington, D.C.: The National Academies Press, pp. 19-34.

D'Este, Pablo; Perkmann, Markus (2011) Why do academics engage with industry? The entrepreneurial university and individual motivations. Journal of Technology Transfer 36: 316-339.

Dahrendorf, Ralf (1965). Bildung ist Bürgerrecht. Plädoyer für eine aktive Bildungspolitik. o.O.: Nannen-Verlag.

Doberneck, Diane M.; Glass Chris R.; Schweitzer, John (2010) From Rhetoric to Reality: A Typology of Publically Engaged Scholarship. Journal of Higher Education and Engagement 14(4): 5-35.

Eckel, Peter D. (2008) Mission Diversity and the Tension between Prestige and Effectiveness: An Overview of US Higher Education. Higher Education Policy 21:175-192.

Einhäupl, Karl Max (2001) What does "basic research" mean in today's research environment? Keynote address to the OECD workshop on "Basic research: Policy relevant definitions and measurement", 28-30 October, Oslo, Norway.

EIT (2012) CATALYSING INNOVATION IN THE KNOWLEDGE TRIANGLE. Practices from the EIT Knowledge and Innovation Communities. Publication for the European Institute of Innovation and Technology (EIT) by Technopolis |group|.

Etzkowitz, Henry (2004) The evolution of the entrepreneurial university. International Journal of Technology and Globalisation 1(1): 64-77.

Etzkowitz, Henry; Leydesdorff, Loet (2000) The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. Research Policy 29: 109-123.

Etzkowitz, Henry; Viale, Riccardo (2010) Polyvalent Knowledge and the Entrepreneurial University: A Third Academic Revolution? Critical Sociology 36(4, July): 595-609.

Etzkowitz, Henry; Webster, Andrew; Gebhardt, Christine; Terra, Branca Regina Cantisano (2000) The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. Research Policy 29: 313-330.

EU Commission. (2006). Delivering on the modernization agenda for universities: Education, research and innovation. Brussels: COM(2006) 208 final.

EU Commission. (2010) Europe 2020. A strategy for smart, sustainable and inclusive growth. COM(2010) 2020 final.

EURASHE (2013a) EURASHE 23rd Annual Conference HIGHER EDUCATION – MAKING THE KNOWLEDGE TRIANGLE WORK. 9-10 May 2013, Split (Croatia). A report by Richard Thorn.

EURASHE (2013b) Public engagement as integral part of the innovation ecosystem. Presentation given by Vladimír Šucha at the EURASHE 23rd Annual Conference.

Furman, Jeffrey L.; MacGarvie, Megan (2009) Academic collaboration and organizational innovation: the development of research capabilities in the US pharmaceutical industry, 1927-1946. Industrial And Corporate Change 18(5): 929-961.

Frey, Carl Benedikt; Osborne, Michael A. (2013) The Future of Employment: How susceptible are jobs to computerisation? Oxford Martin Research paper. Oxford Martin Programme on the Impacts of Future Technology (September) http://www.oxfordmartin.ox.ac.uk/publications/view/1314

Geschwind, Lars; Broström, Anders (2013) Managing the teaching-research nexus: ideals and practice in research oriented universities. CESIS Electronic Working Paper Series Paper No. 316 (June) https://static.sys.kth.se/itm/wp/cesis/cesiswp316.pdf

Geuna, Aldo (2001) The Changing Rationale for European University Research Funding: Are There Negative Unintended Consequences? Journal of Economic Issues (2011), Vol. 35, No. 3. 607-632.

Geuna, Aldo; Martin, Ben R. (2003) University Research Evaluation and Funding: An International Comparison. Minerva 41: 277-304.

Geuna, Aldo, Muscio Alessandro (2009) The Governance of University Knowledge Transfer: A Critical Review of the Literature. Minerva 47:93-114.

Gibbons, Michael; Limoges, Camille; Nowotny, Helga; Schwartzman, Simon; Scott, Peter; Trow, Martin (1994) The new production of knowledge: the dynamics of science and research in contemporary societies. Sage, London.

Gibbons, M. (1999) Science's new social contract with society. Nature, 402/2: C81–C84.

Glass, Chris R.; Doberneck, Diane M.; Schweitzer, John H. (2011) Unpacking faculty engagement: the types of activities faculty members report as publicly engaged scholarship during promotion and tenure. Journal of Higher Education Outreach and Engagement 15(1): 7-30.

Glasson, John (2003) The Widening Local and Regional Development Impacts of the Modern Universities — A Tale of Two Cities (and North-South Perspectives). Local Economy 18(1): 21-37.

Godin, Benoît (2006) The Linear Model of Innovation. The Historical Construction of an Analytical Framework. Science, Technology, & Human Values, Vol.31 Num. 6: 639-667.

Godin, Benoît (2008) The Making of Statistical Standards: The OECD and the Frascati Manual, 1962-2002. Project on the History and Sociology of STI Statistics. Working Paper No. 39.

Göktepe-Hultén, Devrim (2010) A Balancing Act: Factors behind the Formation of Academic Entrepreneurship. Critical Sociology 36(4) 521-535.

Goldstein, Harvey A. (2010) The "entrepreneurial turn" and regional economic development mission of universities. The Annals of Regional Science 44: 83-109.

Grimaldi, Rosa; Kenney, Martin; Siegel, Donald S.; Wrigh, Mike (2011) 30 years after Bayh–Dole: Reassessing academic entrepreneurship. Research Policy 40:1045–1057.

Guerrero, Maribel; Urbano, David (2012) The development of an entrepreneurial university. Journal of Technology Transfer 37:43-74.

Hartl, Jakob; Thaler, Bianca; Unger, Martin (2014), Übergänge ins und im Hochschulsystem im europäischen Vergleich, in: Banscherus, Ulf; Bülow-Schramm, Margret; Himpele, Klemens; Staack, Sonja; Winter, Sarah (Hrsg.), Übergänge im Spannungsfeld von Expansion und Exklusion – Eine Analyse der Schnittstellen im deutschen Hochschulsystem, GEW-Materialien aus Hochschule und Forschung, 121. Bielefeld: wbv, 173-190.

Hervas Soriano, Fernando; Mulatero, Fulvio (2010) Knowledge Policy in the EU: From the Lis-bon Strategy to Europe 2020. Journal of the Knowldege Economy 1(4): 289-302.

Hessels, Laurens K., van Lente, Harro (2008) Re-thinking new knowledge production: a literature review and a research agenda. Research Policy 37: 740-760.

Hoidn, Sabine; Kärkkäinen, Kiira (2014), "Promoting Skills for Innovation in Higher Education: A Literature Review on the Effectiveness of Problem-based Learning and of Teaching Behaviours", OECD Education Working Papers, No. 100. Paris: OECD.

HSV-Swedish National Agency for Higher Education (2009) The Knowledge Triangle Shaping the Future of Europe Summary report from the conference 31 August–2 September 2009. Report 2009:26 R. Göteborg: Sweden http://www.hsv.se/download/18.726d1204123dc555ee67ffe233/0926r.pdf

Huang, Can; Arundel, Anthony; Hollanders, Hugo (2010) How firms innovate: R&D, non-R&D, and technology adoption. UNU-MERIT WORKING Paper Series No. 2010-027. http://www.merit.unu.edu/publications/wppdf/2010/wp2010-027.pdf

Huber, Ludwig (1999) An- und Aussichten der Hochschuldidaktik. Zeitschrift für Pädagogik 45(1): 25:44.

Jencks, Christopher; Riesman, David (1968) The Academic. Revolution. New York: Doubleday.

Jenkins, Alan; Healey, Mick; Zetter, Roger (2007) Linking teaching and research in disciplines and departments. York: The Higher Education Academy.

Jensen, Morten Berg; Johnson, Björn; Lorenz, Edward; Lundvall, Bengt-Ake (2007) Forms of knowledge and modes of innovation. Research Policy 36: 680–693.

Kingma, Bruce, Ed. (2011) Academic Entrepreneurship and Community Engagement. Scholarship in Action and the Syracuse Miracle. Cheltenham: Elgar.Kjelstrup, Signe (2001) Basic and applied research in the university − have they changed? OECD workshop on "Basic research: Policy relevant definitions and measurement", 28-30 October, Oslo, Norway.

Lam, Alice (2011) What motivates academic scientists to engage in research commercialization: “Gold”, “ribbon” or “puzzle”? Research Policy 40: 1354-1368.

Laurillard, Diana (2002) Rethinking Teaching for the Knowledge Society. In: The Internet and the University: 2001 Forum. EDUCAUSE, Boulder, Colorado, 133-156.

Lassnigg, Lorenz; Trippl, Michaela; Sinozic, Tanja; Auer, Alexander (2012) Wien und die „Third Mission” der Hochschulen. Research report. Vienna: IHS.

Lester, Richard K. (2007) Universities, Innovation, and the Competitiveness of Local Economies. An Overview. In: Lester, Richard K.; Sotarauta, Markku (Hg.)Innovation, Universities, and the Competitiveness of Regions. Technology Review 214/2007. Helsinki: Tekes, 9-30.

Lindqvist, Maria; Olsen, Lise Smed; Baltzopoulos, Apostolos (2012a) Strategies for Interaction and the Role of Higher Education Institutions in Regional Development in the Nordic Countries. Nordregio Report 2012:2.

Lundvall, Bengt- Åke (Hg.) (1992) National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning. Pinter, London.

Lundvall, Bengt-A. (2008) A note on characteristics of and recent trends in National Innovation Policy Strategies in Denmark, Finland and Sweden. Paris 2008-11-02 http://www.kunnskapsdugnad.no/portal/page/portal/kunnskapsdugnaden/rapporter/artikkel?p_document_id=746506

Maassen, Peter; Stensaker, Bjørn (2011) The knowledge triangle, European higher education policy logics and policy implications. Higher Education (2011) 61:757-769.

Markkula, Markku (2013) The Knowledge Triangle. Renewing the University Culture. In: Lappalainen, Pia; Markkula, Markku (ed.) The Knowledge Triangle – Re-Inventing the Future. Helsinki: European Society for Engineering Education SEFI, Aalto University, Universitat Politècnica de València.

Mazzoleni, Roberto (2011) Before Bayh-Dole: public research funding, patents, and pharmaceutical innovation (1945–1965). Industrial And Corporate Change 20(3): 721-749.

McNall, Miles; Reed, Celeste Sturdevant; Brown, Robert; Allen, Angela (2009) Brokering community-university engagement. Innovative Higher Education 33(5): 317-331.

Murray, Robin; Caulier-Grice, Julie; Mulgan, Geoff (2010) The open book of social innovation. NESTA/The Young Foundation.

Newcastle University (2009) Characterising modes of university engagement with wider society. A literature review and survey of best practice. First Final Draft, 8th May 2009. Office of the Pro-Vice-Chancellor (Engagement). Newcastle upon Tyne.

Nielsen, Peter; Lundvall, Bengt-Ake (2005). Innovation and job creation in the learning economy. In: Breedgard, Thomas; Larsen, Flemming (eds.), Employment policy from different angles, Copenhagen: DJOEF, pp. 505-521.

Nowotny, Helga; Scott, Peter; Gibbons Michael (2001) Re-thinking science: knowledge and the public in an age of uncertainty. Cambridge, Polity Press.

Nowotny, Helga; Scott, Peter; Gibbons Michael (2003) "Mode 2" revisited: the new production of knowledge. Minerva 41: 179-194.

Oblinger, Diana. (2004). The Next Generation of Educational Engagement. Journal of Interactive Media in Education 8.

OECD (1971) Science, growth and society, a new perspective. Paris: OECD.

OECD (1991) Alternatives to Universities. Paris: OECD.

OECD (2002) Frascati Manual 2002. Proposed Standard Practice for Surveys on Research and Experimental Development. Paris: OECD.

OECD/Eurostat (2005) Oslo Manual. Guidelines for collecting and interpreting innovation data. Paris: OECD.

OECD (2007) Higher Education and Regions: Globally Competitive, Locally Engaged. Paris: OECD.

OECD (2008) Higher education and regional development. Higher Education Management and Policy 20(2). Special Issue. OECD (2008) Tertiary Education for the Knowledge Society: VOLUME 2: Special features: Equity, Innovation, Labour Market, Internationalisation. Paris: OECD.

OECD and Worldbank (2009) Innovation and Growth. Chasing a moving frontier. Paris: OECD.

OECD (2010) Innovation to strengthen growth and address global and social challenges. Ministerial report on the OECD Innovation Strategy. Paris: OECD

OECD (2012a) Fostering Quality Teaching in Higher Education: Policies and Practices. Paris: OECD.

OECD (2012b) Education Indicators in Focus 6. Paris: OECD.

OECD (2012c) Assessment of Higher Education Learning Outcomes. Feasibility Study Report. Volume 1 – Design and Implementation. Paris: OECD.

OECD (2013a) Assessment of Higher Education Learning Outcomes. Feasibility Study Report. Volume 3 – Further Insights. Paris: OECD.

OECD (2013b) The State of Higher Education 2013. Paris: OECD.

OECD (2014a) Measuring Innovation in Education: A New Perspective, Educational Research and Innovation. Paris: OECD.

OECD (2014b) OECD Science, Technology and Industry Outlook 2014.Paris: OECD.

Olsen, Johan P. (2005) The institutional dynamics of the (European) University ARENA Working Paper No.15, March 2005.

Parsons, Talcott and Platt, Gerald M. (1973) The American University. Cambridge, Massachusetts: Harvard University Press.

Perkmann, Markus; Walsh, Kathryn (2009) The two faces of collaboration: impacts of university-industry relations on public research. Industrial and Corporate Change 18(6): 1033-1065.

Perkmann, M.; Tartari, V.; McKelvey, M.; Autio, E.; Brostrom, A.; D'Este, P.; Fini, R.; Geuna, A.; Grimaldi, R.; Hughes, A.; Krabel, S.; Kitson, M.; Llerena, P.; Lissoni, F.; Salter, A.; Sobrero, M. (2011) Universities and the third mission: a systematic review of research on external engagement by academic researchers. Working Paper, Imperial College London.

Philpott, Kevin; Dooley, Lawrence; O"Reilly, Caroline; Lupton, Gary (2011) The entrepreneurial university: Examining the underlying academic tensions. Technovation 31: 161-170.

Pilkington, Marc; Nair, Geeta (2013); Global Trends in Higher Education: An Unexpected Con-vergence between France and India. International Journal of Education Economics and Development 4(1):1-19.

Ramsden, Paul; Moses, Ingrid (1992) Associations between research and teaching in Australian higher education. Higher Education 23:273-295

Rhoades, Gary; Slaughter, Sheila (2004) Academic Capitalism in the New Economy: Challenges and Choices. American Academic 1(1) Issue: Academic Values, Market Values: The Shifting Balance:37-60.

Rothaermel, Frank T.; Agung Shanti D.; Jiang, Lin (2007) University entrepreneurship: a taxonomy of the literature. Industrial and Corporate Change 16 (4): 691-791.

Sandmann, Lorilee R.; Thornton, Courtney H.; Jaeger, Audrey J. (2009) Institutionalizing Community Engagement in Higher Education: The First Wave of Carnegie Classified Institutions. San Francisco: Jossey-Bass.

Schofer, Evan; Meyer, John W. (2005) The Worldwide Expansion of Higher Education in the Twentieth Century. American Sociological Review 70(6, Dec):898-920.

Siegel, Donald S.; Wright, Mike; Lockett, Andy (2008) The rise of entrepreneurial activity at universities: organizational and societal implications. Industrial and Corporate Change 16(4): 489-504.

Śledzik, Karol (2013) Schumpeter's view on innovation and entrepreneurship. in: Stefan Hittmar (ed.) Management Trends in Theory and Practice. University of Zilina.

Stella, Antony; Baird, Jeanette (2008) Community Engagement and and Inclusion in Australian Higher Education: A Thematic Analysis of AUQA's Cycle 1 Audits. Australian Universities Quality Agency.

Sunderland, Naomi; Muirhead, Bruce; Parsons, Richard; Holtom, Duncan (2004) The Australian consortium on Higher Education, Community Engagement and Social Responsibility Foundation Paper.

Tartari, V ; Breschi, S. ()Set them free: scientists' evaluations of the benefits and costs of university–industry research collaboration. Industrial and Corporate Change 21 (5): 1117-1147.

Technopolis (2012) Education in the Knowledge Triangle. http://www.technopolis-group.com/wp-content/uploads/2014/05/OF-35-1613-Final-report-and-case-studies-121212.pdf

Teichler, Ulrich (2008) Diversification? Trends and explanations of the shape and size of higher education. Higher Education (2008) 56:349–379.

TLRP (n.y.) Effective learning and teaching in UK higher education. A Commentary by the Teaching and Learning Research Programme. London:IOE. http://www.tlrp.org/pub/documents/UKHEfinal.pdf

Tödtling, Franz; Trippl, Michaela (2005) One size fits all? Towards a differentiated regional innovation policy approach. Research Policy 34: 1203-1219.

Tödtling, Franz; Lehner, Patrick; Trippl, Michaela (2006) Innovation in knowledge intensive industries: The nature and geography of knowledge links. European Planning Studies 14(8): 1035-1058.

Trencher, G. ; Yarime, M. ; Mccormick, Kes ; Doll, C. ; Kraines, S. ; Kharrazi, A. (2014) Beyond the Third Mission: Exploring the Emerging University Function of Co-creation for Sustainability. Science and Public Policy 41(2):151-179.

Trippl, Michaela; Tödtling, Franz; Lengauer, Lukas (2009) Knowledge sourcing beyond buzz and pipelines: evidence from the Vienna software cluster. Economic Geography 85(4): 443–462.

Trippl, Michaela (2011) Regional innovation systems and knowledge sourcing activities in traditional industries –Evidence from the Vienna food sector. Environment and Planning A 43(7): 1599-1616.

UNESCO (ed) (1995) Higher education capacity building for the 21st Century Proceedings of the 4th UNESCO-NGO Collective Consultation on Higher Education Paris

Uyarra, Elvira (2010) Conceptualizing the Regional Roles of Universities, Implications and Contradictions. European Planning Studies 18(8): 1227-124.

UBC (2011) The State of European University-Business Cooperation. Final Report – Study on the cooperation between Higher Education Institutions and public and private organisations in Europe. Science-to-Business Marketing Research Centre.

UIIN (2014) UIIN Good Practice Series 2014 – Fostering University-Industry Relationships, Entrepreneurial Universities and Collaborative Innovation.

Valentin, Finn, and Rasmus Lund Jensen (2006) Effects on academia–industry collaboration of extending university property rights. The Journal of Technology Transfer 32(3): 251-276.

Välimaa, Jussi; Hoffman, David (2008) Knowledge society discourse and higher education. Higher Education 56:265-285.

Weerts, David J. and Sandmann , Lorilee R. (2008) Building a Two-Way Street: Challenges and Opportunities for Community Engagement at Research Universities. Building a Two-Way Street: Challenges and Opportunities for Community Engagement at Research Universities. The Review of Higher Education Fall 2008, Volume 32, No. 1, pp. 73-106.

Weerts, David J. and Sandmann , Lorilee R. (2010) Community Engagement and Boundary-Spanning Roles at Research Universities. The Journal of Higher Education 81(6): 702-727.

Weingart, Peter (2010) Die „unternehmerische Universität". In: Gugerli, David; Hagner, Michael; Tanner, Jakob (Hg.) Nach Feierabend. Zürcher Jahrbuch für Wissensgeschichte. Diaphanes, Zurich, pp. 55-72.

Westmore, Ben (2013) "R&D, Patenting and Growth: The Role of Public Policy", OECD Economics Department Working Papers, No. 1047. Paris: OECD.

Woolgar, Lee (2013) ERAWATCH COUNTRY REPORTS 2012: Japan ERAWATCH Network.

Authors: Lorenz Lassnigg, Jakob Hartl, Martin Unger, Iris Schwarzenbacher

Title: Higher Education Institutions and the Knowledge Triangle. Improving the interaction between education, research and innovation

Reihe Soziologie / Sociological Series 118

Editor: Beate Littig

ISSN: 1605-8011

Josefstaedter Strasse 39, A-1080 Vienna • ☎ +43 1 59991-0 • Fax +43 1 59991-555 • http://www.ihs.ac.at