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His interest in this topic evolved from contributing to the European Commission's Regional Innovation Scoreboard in 2012 and a growing interest in performance indicators on the regional impact of universities (Tijssen, 2015). He co-authored this book's precursor report "A Regional Innovation Impact Assessment Framework for Universities" that was published in 2018 (Jonkers et al., 2018). His recent academic studies focus on methods to study and monitor research cooperation between universities and business enterprises that are located in each other's close vicinity (Tijssen et al., 2020). His performance indicator on university–business cooperation was launched in the 2019 edition of U-Multirank (Tijssen, 2019). The methodology was also applied across all research-intensive universities in the United Kingdom (Tijssen et al., 2020).

He has been the lead researcher in a number of European Commission sponsored studies, and has served on several expert panels dealing with monitoring and evaluation of science and innovation programmes.

John Edwards worked at the European Commission's Joint Research Centre (JRC) from 2011 to 2020, helping to set up and manage the Smart Specialisation Platform (S3P). A joint initiative of the JRC and DG Regional and Urban Policy, the S3P provides advice to national and regional authorities on the design and implementation of smart specialisation strategies, a key approach of the European Union to promote knowledge and place based economic development. From 2016 he led the project on Higher Education for Smart Specialisation in cooperation with DG Education, Youth, Sport and Culture, which supports the development of partnerships between higher education institutions and regional authorities.

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Prior to taking up the role of JRC Editor-in-Chief, Koen was deputy head of the knowledge for growth, finance and innovation unit of the JRC. In this post he was, among others, responsible for coordinating JRC work on higher education and universities. This included the project on which this book is based. He has published extensively on science, innovation and higher education studies in Europe, Asia and Latin America, including recent work on the performance-based funding of universities (Jonkers and Zacharewicz, 2017). He was also a co-author of the report that formed the initial basis of this project (Jonkers et al., 2018).

Foreword

This book takes a fresh and illuminating approach to a subject whose importance for sustaining innovation and capabilities in regional economies is now widely acknowledged. The regional innovation impact of universities emerged as an issue several years ago, and has included scholarly works exploring their specific role in regional development, smart specialisation strategies and place-based innovation policies. However, it is the first time, to my knowledge, that a framework for a systematic analysis of regional innovation impact (RII) is developed and that the RII framework is tested and validated through a number of case studies which then provide the basis for further elaboration and implementation. My hope is that the book will receive enough due attention among all actors of the quadruple helix to introduce and support policy debates, helping to answer key questions that I think are important today in this matter.

First, the RII framework should help to better understand whether Universities of Applied Science (UAS) have a specific role to play in regional innovation systems, as compared to the more academic and generalist universities. In their recent study, Pfister et al. (2017) show, thanks to their meticulous econometric analysis, that the effects of UAS in Switzerland on the quantity and quality of innovations in the regions concerned were positive. How can these effects be explained? There are two mechanisms: the increase in R&D cooperation and partnerships between UAS and regional industry, plus students' access to regional labour markets, as these students will subsequently innovate in regional companies.

These results need, however, to be interpreted with some caveats, as Switzerland is perhaps a special case. In most countries, UAS sought to approximate the most general approach – i.e. the research universities – in order to earn greater respect and recognition. This trend is known as 'academisation' and can lead to a situation where the UAS and research universities will become so similar that any formal distinction will disappear (Lepori, 2016). However, in Switzerland, it seems that UAS have developed a unique profile: rather than emulating research universities, they have focused consistently on practical teaching and applied R&D. To what extent the academisation trend needs to be avoided, in order to maintain functional differentiation within the higher education system so that UAS have a clear institutional mission towards regional innovation systems, remains an open question.

Second, the RII framework should help to understand how to build better connections between the scientific specialisations of universities and the economic specialisation of the concerned regions. In a well-documented paper, Bonaccorsi (2016) observed that universities active in less-developed regions and in transition regions have, on average, not many but a few excellent scientific fields. He showed also that the scientific fields which most prominently appear in the niches of excellence of universities in these regions are mostly in medical fields and in basic science. As he observed, the opportunities for interaction with regional industry cannot be excluded, but appear on the whole quite limited. This evidence calls for more reflection about the value of co-specialisation between scientific excellence and the business sector in the respective region. It also calls for more work about the process through which such co-specialisation can occur, while not impacting on academic freedom and the decentralised research decisions of university scientists. The way that universities are integrated into regional smart specialisation strategies can provide some elements of responses in this respect (Foray et al., 2018).

Third, and most importantly, the RII framework should help to structure the policy discussion about how to define and measure the scientific excellence of universities. Scientific excellence is a good word – capable of producing a broad base of political and intellectual support. It is a desirable and legitimate goal to be reached by any university. However, does it capture the full impact of a university on a regional economy? The problem does not lie in the concept of excellence as such, but rather in the activities and outputs to which such excellence should apply. I argue that the scope and validity of the concept of 'research and innovation (R&I) excellence' – as defined in the mainstream of policymaking – is quite narrow and would *de facto* exclude many activities and outputs that are seen as central to driving economic development, particularly in less-developed and transition regions.

Indeed, with respect to Cohesion Policy and economic development, R&I excellence cannot be viewed as the only source of productivity, growth and development. In the R&I domain, there are many types of innovation-related actions that are relevant for productivity and growth, such as building-up human capital, adopting (not inventing) new technologies, diffusing novel management practices, generating complementarities between key enabling technologies and traditional sectors, as well as developing social innovations. All these activities are important in order to strengthen capabilities and lever the growth and development potential of a regional economy. They also all need to be included in any regional policy and smart specialisation strategy as important drivers of innovation, growth and structural change. As the great innovation economist Manuel Trajtenberg wrote a few years ago: "They are perhaps less exciting and flamboyant than high-tech and world-class science,

but they ultimately represent the key to economy-wide growth in most regional economies" (Trajtenberg, 2009, p. 376).

Thus, the conventional objective of R&I excellence needs to be complemented by a broader, richer and more complex approach in order to apply to place-based innovation ecosystems. This would require that regional policy develops its own criteria of relevance in R&I which should go beyond the mainstream concept of research excellence. The key point for policymakers to recognise is that the drivers of growth are different in different regions, largely depending on their distance to the technology frontier, and thus universities in different regions will have differentiated tasks.

This book – which proposes a conceptual framework to understand and analyse the regional innovation impact of universities – is important and timely. It will trigger a number of discussions and policy debates, particularly on the questions I have raised here about the specific role of Universities of Applied Science; the way that co-specialisation between research excellence and the business sectors can be improved in regional economies; and the need to complement the concept of excellence with regional relevance.

Professor Dominique Foray
École Polytechnique Fédérale de Lausanne, Switzerland

Preface

Many universities in Europe make major contributions to their home towns, metropolitan areas and regions. But how important are they exactly? What is their actual socio-economic impact on the local environment and communities? How active are they in terms of collaborating with business enterprises and contributing to regional innovation systems? Can universities expand or intensify those connections and interactions? How can we incentivise them to do more? These are all highly relevant questions in this current day and age, where universities are often seen as core contributors to educated societies and resilient economies, yet nobody seems to have any convincing answers.

It is in fact a big black box. We were struck and intrigued – both from a curiosity-driven academic viewpoint as well as from a policy development perspective – by the general ignorance on these topics and the glaring lack of empirical evidence. Addressing this knowledge gap, while certainly a very worthwhile effort, is not the main aim of this book. In this book we do report on our attempt to shine some light into interesting items in that box, more specifically research-active universities in Europe. How do these versatile, multi-mission organisations – many of which also operate internationally and globally – contribute to socio-economic changes in their surrounding area? Driven by European Union (EU) policy challenges, we focus our attention on one specific feature of their impact profile: their '*regional innovation impact*' (RII). How do universities engage with, and directly contribute to, 'regional innovation systems' from an RII viewpoint?

By developing an appropriate conceptual model, and by applying the right kind of analytical approach, it should be possible to find out much more about the RII potential and performance of higher education institutions (HEIs) in Europe. The idea of operationalising the notion of RII was launched in 2017 by the European Commission's Joint Research Centre (JRC), when it was still a relatively novel concept. An exploratory approach was adopted to gauge its possible policy relevance. Our intellectual reconnaissance – mainly on conceptualisation, modelling and performance indicators – resulted in a JCR report entitled "A Regional Innovation Impact Analytical Framework for Universities" which was published in January 2018. The report included a first version of a conceptual model, an outline of an analytical framework for a 'narrative with numbers' approach to information gathering, our definition of four 'RII domains', and an overview of possible RII indicators.

Our RII analytical framework attempted to move beyond a narrow focus on the transfer of research results and enterprise development (spin-offs and start-ups), which has been a dominant feature of previous monitoring and assessment structures. We stressed the importance of capturing a broader potential impact of higher education institutions (HEIs) on their regional innovation systems in Europe: from their input to the development of regional strategies to their contribution to human capital development. Another central feature of the framework is that it strives to incorporate the differences between HEIs and the context in which they operate.

Conducting a 'proof of concept' study was our next step in the development process. Would our approach work in real life? We decided to focus our attention on research-active universities in Europe, many of which operate at local, regional, national and international levels simultaneously. These HEIs are less likely to focus their activities on enhancing local relevance and regional engagement. We ran a series of meetings (Copenhagen, May 2018; Brussels, September and November 2018; Bilbao, June 2019) where we invited stakeholder organisations and universities to present their views on the topic and highlight their RII-related activities. Some 20 universities, scattered across Europe, kindly volunteered to submit self-appraisal reports on their organisation's RII profile. Those case study reports turned out to be a rich source of interesting facts and figures on their RII potential and RII performance.

Our first results from analysing their information encouraged us to start contemplating a follow-up publication. Work on this book began in mid-2019. We aimed to address two key questions: (a) under which conditions could our analytical framework be used for RII monitoring and assessment of such universities? (b) could such an application be linked to EU funding instruments for incentivising universities? An intermediate version of the book's manuscript was discussed with external reviewers in February 2020. During our writing process we spotted some important information gaps in those self-appraisal reports, which spurred us to distribute a follow-up questionnaire in April 2020, requesting universities for background information on their RII potential, in-house incentive systems and perceived RII barriers.

As 2020 progressed we integrated our analytical work on the inputs from those universities with information on relevant European policy issues and a forward-looking appraisal of new EU programmes due to start in 2021. The RII-related policy challenges we address in this book are complex, but familiar to EU policymakers. The European Regional Development Fund, and in particular its emphasis on smart specialisation strategies, has made significant inroads throughout the EU towards improving the performance of regional innovation systems. As a policy concept, RII straddles three directorates general (Policy DGs) within the European Commission: Education, Youth, Sport and Culture (DG EAC), Regional and Urban Policy (DG REGIO) and

Research and Innovation (DG RTD). Feedback from representatives of each DG was incorporated in the second and third quarter of 2020.

By slightly prying open that black box, our findings provide new information of possible interest to several audiences. Our analytical toolkit offers a wide range of applications for several types of users. For example, it may help the leadership of universities who wonder about the scale and scope of their own RII potential, and how to assess, monitor or evaluate their RII performance. It may also be useful for local and regional authorities with an interest in understanding, engaging and mobilising universities for more cooperation and engagement, who are perhaps struggling to create RII awareness among local universities and are on the look-out for helpful 'good practices' from other places. Our third targeted user group is of course policymakers, at various levels in Europe, where our general observations and conclusions could be of support in developing instruments or incentive schemes to promote or enhance RII activities within universities and with regional engagement partners.

As a final note to our readers, especially those pressed for time, the one-page introductory texts at the beginning of each part summarise the main storyline. Part I (Chapters 1 to 3) is mainly concerned with introducing the RII concept and its assessment, while Part II analyses self-appraisal reported RII activities within a set of selected European research-active universities (Chapters 4 to 8). Part III (Chapters 9 to 11) focuses on the further development and implementation of an RII assessment framework within the context of European funding instruments. Chapter 9 is a pivotal chapter; it draws lessons from the practical implementation of the analytical framework and explores how it should be operationalised to allow for assessments that can be tied to funding instruments.

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Many of the above-mentioned people also participated in our RII meetings which brought together representatives of universities, regional governments and EU officials from the Commission's policy DGs. Special thanks also go to those who organised and hosted these events:

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Often these meetings were jointly organised with university associations, which also helped us with the identification and involvement of universities in the drafting of the case study reports. We would like to thank especially Lydia Borrell Damian (EUA, currently at Science Europe), David Bohmert (CESAER); Ricardo Migueis (CESAER); and Olga Wessels (ECIU) for their support.

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- European Week of Cities and Regions (Brussels; October, 2017);
- El impacto económico y social de las universidades en su entorno (Madrid; January, 2018);
- T2S event (Valencia; October, 2018);
- HEInnovate event (Ruse; November, 2018);
- Impact of SSH for a European Research Agenda (Vienna; November, 2018);
- ASTP-Proton annual event (Dublin; May, 2019);
- Supporting Smart Specialisation Strategies and Technology Transfer in South-East Europe (Bucharest; June, 2019);

… and on presentations by Robert Tijssen:

- Innovation Ecosystems, Technology Upgrading and Regional Development (Campinas; June 2018);
- Data science and STI indicators (Maastricht; May 2019).

We are also deeply indebted to all those staff members at various Policy DGs of the European Commission for their active participation in meetings on RII-related issues, and willingness to review draft versions of the manuscript or separate chapters: Georgi Dimitrov, Gauthier Grousset, Peter Baur, and Sumathi Subramanian (DG EAC), Richard Deiss and Denisa Perrin (DG REGIO) and Rinske van den Berg (DG RTD).

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PART I

Regional innovation impact: an introduction

Universities are organisational structures embedded (to varying degrees) in the places where they are located. They are also an integral part of larger, complex social systems – not only their local civic society or national higher education system, but also the domestic and international economy, as well as regional or national innovation systems. Fulfilling their numerous societal missions, universities engage and interact with a wide range of customers, users, and partners – some of which are in close proximity, while others are at large distances. Those connections and interactions may have very significant impacts on external environments; universities can be important change agents in local and regional societies and economies. Addressing the increasing interest among policymakers to know more about the socio-economic impacts of universities in Europe, this book focuses on their 'regional innovation impact' ('RII' for short). More specifically, their (potential) engagement with, and actual impact on, the 'regional innovation system' within their host city, urban agglomeration or surrounding area.

Determining the nature and intensity of universities' RII-related engagements is a challenging task; identifying and valuing their impacts is even more difficult. In this book we offer a new way forward to capture and assess the RII profile of universities. Our evidence-based approach is based on a series of empirical studies of research-active universities in European Union Member States. The three chapters of Part I discuss the rationale for this book and introduce the conceptual model and analytical approach we developed.

Chapter 1 sets the scene by describing the current circumstances under which many universities operate with regard to their local or regional engagement activities. It presents a definition of 'regional innovation impact' and introduces a conceptual model of an 'RII system' in which a university and its local environment are intertwined and interdependent. The 'RII delivery space' connects both domains: this domain consists of the university's RII pathways and 'places and spaces' where external impacts may occur.

Chapter 2 presents our 'RII analytical framework' specifically designed to describe, grasp and monitor a university's RII potential and performance. Rejecting a numbers-only 'one size fits all' methodology, we suggest a customised 'narrative with numbers' case-by-case approach to gather and interpret RII relevant information and data.

Chapter 3 introduces several broader perspectives on RII analysis: the geographical and institutional settings in which universities must operate, but also, focusing on policy environments, 'Theory of Change' led interventions or incentives that may shape and drive the future RII profile of universities.

1. Universities in Europe and local engagement

1.1 RESEARCH UNIVERSITIES IN EUROPE

Currently, the European higher education landscape is characterised by a diversity of organisations devoted to teaching and training.[1] Each has its own niche and contributes to society in different ways. Many are relatively small-sized, while some universities[2] have tens of thousands of students and staff. The primary mission of universities is to offer a stable environment for the education of learners and students; their main product is to deliver well-trained and skilled graduates. Through their teaching and training activities these organisations may act as engines for social mobility, contribute to social and cultural development, and provide inputs for citizenship development and the human resources for knowledge-based economies. Delivering highly qualified workers as well as high-quality knowledge for general usage, most universities have been key contributors to municipal, regional[3] or national societies.

The European Union Member States collectively hosted 2 593 Higher Education Institutions (HEIs) in 2016, including 1 009 universities. Almost

[1] A Higher Education Institution is an organisation providing higher, postsecondary, tertiary, and/or third-level education (levels 5–8 of the International Standard Classification of Education structure). The main organisational mission of universities is teaching and training of students.

[2] A 'university' is a doctorate granting HEI with an official research mandate, and/or inclusion of scientific research in its strategic objectives and plans, that have one or more institutionally recognised research units, and at least one regular PhD programme. Some universities have distributed campuses, across various locations. Other universities run one or more branches in other regions or countries.

[3] In this book we will denote a 'region' as a within-country area; either an administrative entity or a spatial territory. In practice, universities may apply the term without any pre-defined or clear geographical demarcation, or perceive their region more broadly, where the designated area extends into a neighbouring country. With regards to the 'distributed universities', those with several campuses or branches (in the same region, country or elsewhere), our discussion of the 'region' and RII analysis will only focus on the area or territory surrounding the university's main campus or home city.

every NUTS2[4] region in the EU28[5] had at least one HEI within its territory, while 59% of the NUTS3 level sub-regions hosted an HEI (ETER, 2019). In this book we focus our attention on one specific type of HEI: research active universities.[6] There is no generally accepted definition of such universities and hence no official statistic on their numbers within the EU. If we apply a conservative estimate by selecting all HEIs indexed by the U-Multirank database (www.umultirank.org; 2020 edition) that produced at least 50 international research publications in a recent four-year period, we count 725 HEIs in the EU28 and 590 in the EU27 (excluding the United Kingdom). As public sector organisations, these universities have two main institutional missions: education and scientific research. Research universities are a hotspot of learning and skill development, but also a reservoir of creativity, knowledge and know-how. Universities have an essential role in developing human talent. They are, by their very nature, well suited to provide creative and innovative solutions to address complex societal problems and challenges; the combination of knowledge domains allows them to contribute from different perspectives where students can experience hands-on projects in problem-based, interdisciplinary contexts.

Scientific research gradually entered the mission portfolio of universities in the 19th century, an era in which the United Kingdom founded many 'civic' universities, often with financial support from business and the local community, to underpin the development of its industrialising cities (Goddard and Vallance, 2013), while the US Land Grant universities had a similar role (Rosenberg and Nelson, 1994). Germany saw the establishment of the Humboldtian universities (Östling, 2020), although their specific regional role was less pronounced. The societal and economic impact of research universities have greatly expanded ever since. The European higher education sector boomed in the second half of the 20th century, driven by a massification of student numbers and rising budgets from governments for science. Nowadays, many universities are heavily involved in scientific research; they tend to conduct a significant amount of 'basic' discovery-oriented scientific

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[4] The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU for the purpose of collecting, developing, and harmonising of statistics at regional level.

[5] The EU28 refers to the current 27 Member States of the European Union and the United Kingdom, which withdrew on 31 January 2020. We use this term when referring to data before this date which includes the United Kingdom.

[6] Throughout the book we will intermittently use the term 'research active university', 'research intensive university', 'research university' or simply 'university' to denote the multi-mission universities that provide education, conduct scientific research, and are engaged in 'other services'.

research but also 'application oriented' research, with support to related socio-economic and technological development. Large-sized research universities in Europe are expected to conduct 'excellent' scientific research with a noticeable scholarly impact.

Academic research is no longer only about creating stocks and flows of scholarly knowledge; the transfer of technical expertise, advanced skills or opening up university infrastructures for economic utilisation has become a vital 'third mission' of many universities.[7] Playing a key role in many national or regional innovation systems, research-active universities create and disseminate knowledge and skills for the benefit of their students, staff and external users. Such engagement is increasingly seen as one of the three main functions of the higher education sector, reflecting the responsibility of universities to provide social, economic or cultural benefits to wider society. Effective engagement is an interactive, bi-directional process that renders universities more responsive to societal needs and enhances the relevance and impact of higher education and research activities.

Towards the turn of the century 'civic engagement' and 'community service' gradually emerged as topics of strategic interest within university management (e.g. Bok, 1982; Kerr, 2001). Universities now offer a range of professional services beyond teaching, training or knowledge production. As 'multi-mission' organisations – that are governed to create a sustainable and responsive environment for productive interactions between students, staff, civic society and the business sector they have become intertwined with their host societies and local economies. The university's third mission and its social purpose has become ever more prominent during this millennium. A fair share of the universities with an extensive volume of third mission activities – often universities of technology – played a key role in promoting entrepreneurship and job creation, marked by the rise of the 'entrepreneurial university' in the 1990s (Clark, 1998). Its economic impact is often seen as intricately linked to the ability for fostering 'knowledge intensive entrepreneurship' (Malerba et al., 2015).

The expanding portfolio of organisational missions has brought their wider civic engagement mission to the fore during the last decade,[8] especially their ability to develop and apply new ideas, services and products of

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[7] Molas-Gallart and Castro-Martínez (2007, p. 321) define the 'third mission' as: "All activities concerned with the generation, use, application and exploitation of knowledge and other university capabilities outside academic environments."

[8] The rise of the civic engagement mission of universities in Europe is driven by various factors. It is partly a response to growing inequalities in terms of socio-economic opportunities within cities or regions, but also a reflection of changing policies in higher education (see e.g. Benneworth and Osborne, 2014).

socio-economic relevance – what we now usually describe as 'innovation' (Uyarra, 2010; Uyarra and Flanagan, 2010). Increasingly, universities are also considered to be places that launch their own knowledge-based innovations and/or contribute to the development of innovative, marketable products that are produced elsewhere. The partners or customers of such 'entrepreneurial' or 'innovative' universities may involve business enterprises, government agencies, civic society organisations, regional development agencies, or individual citizens. Universities may, for example, collaborate with private firms to help co-develop a more competitive business sector, or close gaps between academic research and business-sector technological innovation. However, these market-driven innovations are just one component.

Although less visible from an economic viewpoint, many universities are also involved in community engagement, which has increasingly become a major part of a university's 'soul' (Brink, 2018). It may include student volunteer projects, service-learning, community-based participatory research, community access to sports facilities, or the co-organisation of cultural events. The outcomes are diverse and may include 'social innovations': new ideas, initiatives and developments in areas such as education, cultural development, environmental protection, or social awareness. Impacts of such innovations can be far-reaching, although a university's civic engagement is often focused on the local area – either in their home town or the wider metropolitan area.

1.2 UNIVERSITIES AND REGIONAL DEVELOPMENT

The socio-economic contributions of universities to their home town, local region or country have long been thought to be considerable (Cooke, 1970). Studies by Caniëls and Van den Bosch (2011), and more recently by Kempton (2019), provide general overviews of factors that determine the role of universities as contributors to regional innovation and regional development. The university's organisational size, and the geography of higher education, are two such factors. Some universities are firmly rooted in their local cities or metropolitan areas; their outreach and level of engagement, along with strategic plans and long-term vision statements testify to this embeddedness and their degree of commitment. Their relative regional footprint is the reflection of community orientation and local circumstances.

Whereas smaller universities in rural areas are more likely to mirror the societal fabric and economic specialisation of their local area and regional hinterland, large universities located in urban areas or metropolitan hubs tend to be more diversified in their teaching programmes and research portfolios. Rural universities may provide (inter)national gateways for their regional communities, while urban universities can collaborate with city authorities to implement

development strategies and urban revitalisation. Large research-intensive universities are more likely to be 'spatially blind' in terms of pursuing a teaching or research agenda without an explicit municipal, metropolitan or regional focus. Some of those universities may nonetheless have regional innovation at the heart of their activities, but do not necessarily perceive themselves as a 'regional university'. However, in general they are more likely to downplay their local relevance and are less concerned with challenges, tensions and problems regarding their regional engagement. Their regional orientation is often implicit rather than explicit, and their regional engagement may not be a separate strategic dimension but integrated in educational and research activities. In such cases, their identity and aspirations are likely to be driven by broader organisational missions or long-term visions on the university's goals, achievements and impacts in the world, or by a more implicit focus on community engagement, in terms of, for instance, organisational goals related to sustainable development, inclusion and social commitment.

No large-scale systematic study has ever been undertaken to assess why some universities are much less inclined, or much more, than others to engage locally or regionally. We simply lack the appropriate information sources to conduct such large-scale systematic studies based on comparative empirical evidence. Accelerated by impacts of the current COVID-19 pandemic, many universities are undergoing deep organisational transformations. Challenged by a variety of social and economic forces, universities in general, like many other traditional institutions in society, find it difficult to embrace radical change in their internal structures. Organisational inertia, financial barriers, work culture obstacles, managerial practices, or human resource constraints may hold them back. The vast literature in the field of higher education studies offers a wide range of change-limiting factors, both organisational ('internal') and environmental ('external'), that help explain the relative neglect of local community services or other regional engagement activities. With regards to the organisational side, many universities have been affected by mission expansion and diversification during the last 20 to 30 years. On top of their traditional educational and research missions, large and comprehensive universities have faced a seemingly never-expanding stream of tasks, requests and demands from government funders and other major stakeholders.[9] Nowadays,

[9] The following non-exhaustive list is illustrative of how large and diverse the task load may become: offer access to learners and students; provide living and transport facilities to students; provide teaching and training inspired by research and science; employ new and more effective teaching techniques; deliver sufficient numbers of skilled workers and human talent; ensure employability of its students; produce advanced knowledge for problem solving; conduct excellent scientific research; demonstrate quality, societal relevance and social responsibility; act as an engine for

universities are also increasingly subjected to government pressures and political desire to contribute more to local or national economic development (e.g. Mejlgaard and Ryan, 2017). Managing such a gradually expanding portfolio leaves little room for further development or prioritisation of regional engagement. Municipal or regional engagement can bring benefits, but also distractions from other tasks and missions. Not surprisingly, when pursuing such diversified ambitions, the local city or region's regional mission may be perceived as of lesser importance on a university's list of strategic priorities.

Management systems and organisational culture are another cluster of institutional factors that may hamper regional engagement. Universities are professional work organisations that are only very generally steered by executives with regards to their outreach in the host city or immediate surroundings. The university's organisational culture – a product of its core values, norms or beliefs – is an important determinant of the value it can add, but it is also driven by domestic or global factors such as high-profile collaborations, measures of excellence or funding structures. Funding is largely shaped by national policies and tends to be determined by the volume of student enrolments or number of graduates. Universities may therefore lack sufficient organisational autonomy to develop added value with a regional development dimension. External pressures to engage in regional activities may also conflict with a university's strategic plans.

Governance structures also matter. The role of university leadership is often fundamental in shaping effective engagement relationships with regional actors, which is shown by the examples of Aalborg University (see also Appendix C) and Aalto University (see also Rissola et al., 2017). Without such leadership nothing or very little will happen regardless of other factors. Regional development policies and initiatives may not survive the test of leadership changes. And a lack of a common view between university leadership and representatives of regional bodies in the university's board of trustees may hamper the development of strategies for more effective regional engagement. However, university leadership and executives may have limited capacity or managerial tools for steering their staff behaviour, especially in large research-active universities with global ambitions. At such universities, many of which can be typified as 'loosely coupled' organisations (Benneworth et

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social mobility; contribute to citizenship development; participate in societal debate; address global challenges like climate change and poverty reduction; create infrastructures and socio-economic environments that allow technological innovation and (social) entrepreneurship; provide inputs to technological innovation; engage in technology transfer and cooperate with the business sector; earn an income from the marketplace; contribute to municipal, regional or national competitiveness; produce new ideas and insights with significant societal or cultural impacts in local communities.

al., 2017a), decision-making is often decentralised to faculties or departments. Even though the executive level at universities may have adopted a positive stance on engagement with other actors in the local city or region – usually expressed in a high-level strategic plan or a general mission statement – that sense of commitment may be less present at the level of departments or other organisational units that lack dedicated resources, managerial strategies or organisational efficiencies to interact and cooperate with regional public authorities, local businesses or other potential partners. Radical changes in longer term visions are then likely to meet resistance within the organisation.

Regional engagement is usually not considered a key criterion for promotion of university professors, nor are there prestigious prizes to be won by academics for such 'third mission' activities (Stanton, 2008; Benneworth, 2012). As a result, such engagement is too often dependent on the drive and motivation of a few individuals, rather than pursued as an organisation-wide ambition (Kempton, 2016). Most incentive structures or academic recognition systems are shaped by national funding systems and regulatory regimes that have little effect on promoting or stimulating a local or regional orientation by universities (Charles et al., 2014). The agendas, priorities and careers of academics engaged in research activities are much more likely to be determined by a striving for (inter)national 'scientific excellence'. The 2014 edition of the Research Excellence Framework in the United Kingdom introduced non-academic impact as a component to measuring research excellence. The results showed that just over a third of the 6 795 impact case studies submitted by UK universities described social or economic impacts; most of those tended to be international impacts rather than domestic or regional ones (Kempton, 2019).

Globalisation has become an increasingly important determinant in university strategic management. During the last two or three decades many universities embraced the tempting opportunities offered by internationalisation and digitalisation. Driven by economic considerations, universities have prioritised their international prestige and global outlook to enhance their attractiveness for lucrative foreign students or industrial partners. Universities with an explicitly regional focus might actually be regarded as 'second tier' by those national policymakers whose main concern is national achievement or international measures of success (Hazelkorn, 2016). Localisation and regionalisation seem to have taken a back seat to globalisation processes – especially in the case of research active universities in countries with a strong position in the global higher education arena such as the United Kingdom (Tijssen et al., 2020). Nonetheless, a university's regional engagement can be mutually com-

patible with its global outlook, especially in the current era where most 'grand challenges' that societies are facing have both global and local ramifications.[10]

Counteracting these dominant structural patterns in favour of more regional engagement is difficult, but not impossible – most universities tend to adapt quickly to any major financial opportunity that presents itself with regard to their third mission. Nonetheless, short-term funding opportunities and other incentives – at either the organisational, municipal or regional level – are usually dwarfed by the available longer-term resources and high-reward initiatives made available at the national or supranational level. The university's regional impacts and its related third mission's achievements are likely to be less recognised and severely undervalued.[11] Unfortunately, 'regional impact' is largely ignored in most world university ranking systems and their lists of performance indicators (Hazelkorn, 2018).[12] Although some ranking systems incorporate employer surveys, providing a general idea of student employability, none of the current rankings explicitly take into account their capacity to respond to the need for skills adapted to the local labour market nor the regional innovation achievements of universities. Clearly, such ranking systems penalise smaller universities or those that are primarily engaged in tertiary vocational education and training. Not surprisingly, many universities are looking towards other ways, such as *HEInnovate*,[13] to develop or monitor their innovation potential and entrepreneurial capacities.

Even if dedicated policies and incentive systems exist within universities to promote or support local engagement, the university's organisational history or cultural heritage may prove a supply-side impediment for achieving high levels of commitment and engagement. Supply/demand mismatches are almost inevitable given the complex dynamics of modern societies and interconnected economies. Lack of opportunities for collaboration with civic society partners

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[10] Whereas UNESCO's Societal Development Goals (SDGs) is probably the best known example of grand challenges with a focus on low- and middle-income countries worldwide, Europe's grand challenges are more related to energy transition, health (ageing, obesity), urban quality of life, and sustainable economic development and competitive advantages (e.g. European Commission, 2019a).

[11] The core concept 'impact' (or alternatively, 'influence') is too complex to pin down in any satisfactorily comprehensive way owing to its non-linear, emergent, and diffuse nature. This book will nonetheless operationalise impact in the context of identifiable or measurable consequences of university action (be it intentional or unintentional) on their municipal or regional innovation system.

[12] The available information on regional impacts and engagement may increase in the future as a result of ongoing technical developments within some world university systems such as U-Multirank.

[13] HEInnovate, an online self-assessment platform, is further introduced in subsection 3.2.

within the local region, or fledging knowledge-absorptive capacity of business enterprises, may have mitigating effects on the demand side. The university's educational offerings or its research profile may not align with the needs of the municipal or regional economy (Birch and Cumbers, 2010). Their home town might suffer from its industrial structure having insufficient absorptive capacity or the local region may be comprised of loosely coupled rural communities. In the extreme case, large research-intensive universities may be perceived as 'cathedrals in the desert' (Morgan, 1997), sources of knowledge that are located in 'peripheral' regions with hardly any knowledge-based industry and low levels of absorptive capacity. At the other extreme, we may find specialised private colleges operating in a dynamic and diversified metropolitan area with a very competitive local higher education environment, in other words 'service providers in the big city'.

In both cases, it is important to note that such varied environments do not necessarily determine the actual 'functional spaces' in which universities are most likely to create significant socio-economic impacts and benefits. The university may operate within a regional environment constrained by national regulations or municipal bureaucratic obstacles. Universities are characterised by their own unique impact profiles, that may reach far beyond what is considered their locality or region. Funders tend to treat universities as relatively homogeneous organisations and fail to recognise significant levels of diversity (Uyarra and Flanagan, 2010), where differences are amplified by the local or regional policy environments and socio-economic circumstances in which they operate (Edwards et al., 2017).

Not surprisingly, universities often feature prominently as core components of regional innovation policies (Huggins and Johnston, 2009a), with a special emphasis on their developmental potential in peripheral regions (Huggins and Johnston, 2009b; Huggins and Kitagawa, 2012; Brown, 2016). Despite the many obstacles and disincentives mentioned above, most universities in Europe aim to meet – to varying degrees, in multiple ways and under different conditions – the diverse societal and economic needs and wants in their surrounding region. Universities may play a pivotal role in their region, both as knowledge producers and as an interface between public and private sector partners. Strategic regional engagement with a range of municipal and regional partners may create incentives and infrastructures within universities to manage and steer such processes and contribute to public–private networks (Chatterton and Goddard, 2000). The notion of 'regional innovation systems' (Cooke et al., 1997; 2004; 2011) puts universities at the heart of regional knowledge economies and innovation-driven networks. Many universities have always been core actors in regional innovation systems and contribute to economic development, especially in high-income regions and countries (Goldstein and Drucker, 2006; Drucker and Goldstein, 2007).

RII success stories are highly dependent on the local supply of knowledge and resources. In some cases, universities act as powerhouses for urban and rural development, where universities partner extensively with local and regional authorities, and closely linked knowledge-intensive firms in the business sector. Such levels of regional engagement tend to create positive agglomeration effects in terms of connections and collaborative networks within regional knowledge infrastructures. In other cases, universities may simply lack the sense of urgency, critical resources or necessary infrastructures to develop or exploit relationships with external partners for the purpose of regional development. Opening up and collaborating with external partners can bring an innovation dividend to their local regions, where universities can act as a pipeline or as a node in a local network, allowing actors in the region to access global knowledge resources. Such knowledge spill-over or network effects may extend far beyond the host town or region. Usually it is not universities as strategic bodies that engage with the region but academics who are pursuing their own agenda and goals. These individuals and their teams engage through many different kinds of activities and relationships that are not always clearly visible and almost impossible to measure or count. But the fact that individual initiatives are often 'under the radar' does not mean that they should be downplayed or ignored. Both 'soft' social innovation activities and 'hard' technological innovation actions are important. But the soft side tends to be undervalued; while their contributions are comparatively small and diverse, all those commitments, linkages and activities may add up to a substantial regional impact.

Getting universities to contribute to regional innovation processes can be problematic. Universities do not always have the right kind of incentive structures to become more heavily engaged with regional partners, partially because they are not meant to act as regional development agencies and also because of organisational practices which are, by nature, difficult to change and often resistant to external pressure. So, how to encourage universities to improve their level of engagement, to become more participative and responsive? Universities would need to strengthen their societal position, beyond the traditionally accepted organisational parameters, to enhance their regional impact. The European policy challenge lies in developing effective initiatives, incentives, and interventions – focusing on higher education, science, technology and innovation – that may help improve knowledge spill-overs from universities (e.g. Laranja et al., 2008).

However, the range of options and opportunities for engagement differs between universities and their home regions. Universities in many European countries enjoy a considerable amount of organisational autonomy, a result of historical developments stretching back to earlier centuries, or more recent national governance arrangements. This situation severely limits the options

for regional, national and European policymaking actors to directly steer the behaviour of universities. Nonetheless, universities in Europe are heavily dependent on funding from external sources – either institutional funding, project funding from public sources, or income streams from private and public sources in the form of contract research. In many countries additional income is generated through student fees and as compensation for services offered to external parties. This dependence on external funding can offer policy actors the potential to influence university behaviour.

There are three main kinds of territories or situations that are likely to suffer from suboptimal levels of regional engagement: fragmented cities, old industrial regions, and remote rural areas. Although some universities are actively involved in urban or rural regeneration projects (Addie et al., 2018), the general tendency among many universities to disregard the local socio-economic environment has become a policy problem of some urgency, especially among European Commission policymakers. Policy reports state that universities could and should open up and contribute more to their own city and region than they are currently doing. In their assessment of universities in Europe, the Pascal Lamy-chaired 'Independent High-Level Group on maximising the impact of EU Research and Innovation Programmes' argues for a programme of institutional 'modernisation' for universities to accelerate that process (Lamy et al., 2017).

Supporting universities to evolve further in this direction may require new instruments at the European, national or regional level. Over the past two decades, governments across Europe have implemented performance-based funding systems for the allocation of institutional funding to universities according to *ex post* assessments[14] of their research performance (Jonkers and Zacharewicz, 2017). Some of these funding systems assess and incentivise universities based on other, broader missions including their societal impact. Both the Lamy report and the RISE report (European Commission, 2019b) also mention the possibility of top-up institutional funding streams for universities in EU Member States, on the basis of their 'innovation performance', to enhance the positive effect these organisations can have on regional innova-

[14] For the sake of simplicity and clarity, we will use the catch-all word 'assess' (or 'assessment') throughout this book, rather than to differentiate between *ex ante* 'assessment' and *ex post* 'evaluation'. This distinction could lead to confusion in cases where the formal status of the review, or its (ultimate) operational objective, are ambiguous or not specified. The term 'monitoring' is applied to systematic processes aimed at observing progress and/or measuring temporal changes of an entity over a sustained period of time.

tion systems. The RISE report, produced by an independent group of policy experts, contracted by the European Commission, argues:

> At the regional level, HEIs can mitigate this shortcoming by being catalysts in the creation of regional, inter-regional and global quadruple helix clusters that can be mobilised to enhance their region's social and economic impact through the global exchange and sharing of research and innovation knowledge, learning and experience (pp. 49–50)[15]

and recommends the introduction of an additional funding stream:

> … giving extra funding, not simply as a prize but perhaps in some kind of longer-term funding, to universities that meet different innovation targets, or better still (in terms of changing incentive systems) to universities whose professors on average meet certain innovation targets, such as spinoff companies, curricular innovations, local employment growth, representation on company boards, participation in product development teams or other engagement measures. (p. 83)

Such performance-based funding resonates with the above-mentioned 'modernisation' agenda, but issues of operationalisation would need to be placed within an appropriate framework that stimulates universities to develop or transform their regional engagement portfolios in the desired direction. The wider innovation-oriented agenda within the EU, and reflections on ways to promote the contribution of universities to regional economic development has spurred studies within the European Commission to develop a model and framework that can assess contributions and positive impacts of universities to their regional innovation systems (Jonkers et al., 2018).

The design of corresponding incentive systems and funding mechanisms may strongly influence the way universities position themselves as actors within local or regional innovation systems, as they provide both incentives for individual students and staff, as well as the organisation as a whole. Any progress on this issue requires a cautionary approach where expectations are set at an appropriate and realistic level. If we assume the policy problem might be solved by government policy interventions or funding instruments, which strategic issues and challenges should then be addressed within the context of evolving and often controversial policy goals across Europe? How to encourage universities to re-value and enhance their regional innovation footprint, given that most of the current incentive systems steer universities away from higher levels of regional engagement and more cooperation with regional partners? These questions are addressed in Part III of this book.

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[15] For more information on the 'quadruple helix', see the first paragraph of section 3.1.

Clearly, any proper appreciation of regional missions and local aims requires a better understanding of the broad range of interconnected factors by which their regional engagement is initiated, driven and determined (Benneworth et al., 2017b). Such an understanding starts with creating as much clarity as possible with regards to the complex nature of the problem, where results of this diagnosis are then used to develop practical solutions. If there is one clear message from the history of European policy cooperation over the last 40 years, dating back to the 1980s CERI report 'The University and the Community' (Centre for Educational Research and Innovation, 1982),[16] it is that universities' regional engagement and contributions to innovation systems are complex and difficult to address.

Analytically, we are dealing with a 'wicked problem' (Churchman, 1967), one that can never be satisfactorily solved, because of adaptive social systems. The highly dynamic nature of underlying processes renders it difficult to systematically identify and monitor the nature and intensity of university contributions. First, one needs to identify the opportunities, challenges and tensions that universities may face in those missions, to be analysed with an appropriate contextualised model, a versatile analytical framework and robust empirical data. Second, any approach is only one of a wide variety of possibilities, each introducing a particular perspective of how universities (might) engage with their local and regional environment. Irrespective of the analytical lens, a thorough understanding of key concepts, in our case 'regional innovation impact', is the bedrock of any sound approach.

1.3 WHAT IS 'REGIONAL INNOVATION IMPACT'?

Introduced as a new abstract concept a few years ago (Jonkers et al., 2018), the construct 'regional innovation impact' (RII) derives its meaning from the alignment of three attributes: 'region', 'innovation' and 'impact'. Basically, RII refers to an immediate effect or longer-term influence (the 'impact') of an innovation that occurs (or has occurred) within a particular local geographical area. RII is a slippery concept. It is multi-dimensional, interactive, time-dependent, and context-specific. If we want to link RII to universities and their impacts, we need to be more specific. In this book, we define RII as:

> an immediate or longer-term impact of an innovative outcome, within a local geographical area, which is directly linked to resources, processes or outputs that

[16] The CERI report studied the tendencies of universities to interact and cooperate with nearby communities. The report presented the best practices of university engagement, including North East London Polytechnic Company and Catholic University of Leuven in Belgium.

involve active participation of individuals and/or sub-units within a higher education institution located in that same area.

In this context it is important to stress that RII is not synonymous with a university's 'third mission', the latter being a much broader domain of activity. It distinguishes between innovation outcomes that benefit the economy and society at whatever geographical level, with those that have a clear impact within the locality (Goddard and Vallance, 2013). The geographical factor is essential in defining and identifying RII. For example, innovation projects with firms outside the region are part of a university's external 'third mission' engagement, but do not necessarily have a local economic impact. Conversely, the geography of such impacts can be blurred because RII may have 'spill-over' effects and benefits outside the region (see section 1.2).

As for 'innovative outcome' and its underpinning generic concept 'innovation', we will also need to be more specific. Since there are so many definitions and descriptions of 'innovation' in the management literature and business practice, we settle for a simple, summarised version of a more sophisticated international definition that is used by many (supra)national statistical offices in innovation surveys specifically targeted at business enterprises and data-gathering on economic development (OECD/Eurostat, 2018): An Innovation is "a novel or significantly improved product, process or service".[17]

Adopting the OECD/Eurostat framework and applying this relatively simple definition, the 'innovation' always materialises in an external user environment. The novel or improved '*product, process or service*' can only be perceived and acknowledged as an innovation by external customers, consumers, partners or other 'third party' users – either individuals or organisations within civic society or the business sector. Innovation impacts can therefore only occur outside the university. Moreover, adopting this particular definition of innovation, most universities are likely to be 'RII active', albeit in different degrees and ways. First and foremost, through their graduates getting employed, either in local public organisations and business enterprises, who will deploy the graduates' knowledge and skills to introduce innovations in their workplace. In this sense, a university's regional impact cannot be limited to its 'third mission' activities, since it is integrated with its other mainstream activities, namely education and research.

[17] The full version of this definition, as mentioned in the *Oslo Manual 2018*, is: "An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD/Eurostat, 2018, p. 60).

Trying to pin down RII obviously invites different perspectives on what the innovation actually is, or the nature of the innovation impact. Notably between 'producers' and 'users': regional authorities may have a radically different view of RII from that of universities, where disagreements may occur over if, when and how an alleged 'effect or influence' actually happened. Discernible impacts may range from short-term minor contributions, generated by small-scale individual projects of individual students or staff, to major longer-term benefits from large-scale infrastructure programmes or core missions of universities. RII may, for instance, include newly minted graduates moving into jobs where they can apply their knowledge and skills to improve management practices, but also PhD students starting up companies to co-develop IT solutions in collaboration with local community workers, or university professors advising regional government authorities on how to deal with environmental problems. They can also include high-profile, public–private initiatives such as new science parks or innovation hubs co-developed and co-managed by universities, local governments and business sector partners. It is within such 'place/space' environments that universities can go about creating RIIs to develop or support knowledge-based regional innovation systems.

Some European policy advisors (see the above-mentioned reports by the Lamy and RISE expert committees) argue that the innovation impacts of universities are less than what one would expect to see, or what is badly needed in the current economic circumstances. This would mean that universities are not fulfilling their RII potential. True or false? The policy perspective matters to address this question. Adopting a broad definition of 'innovation' as we do in this book (see above OECD/Eurostat definition), it is clear that universities can contribute to such innovations in many ways. European innovation policies tend to focus on 'technological innovation', where academic scientific research or university-developed prototype technologies may provide essential inputs to innovation processes. However, an overemphasis on the role of science and technological development in innovation may gloss over the most valuable output of universities for society and the economy: their smart and creative graduates, who can lead and catalyse the long-term provision of new knowledge and ideas and are technologically savvy and innovative. The skill set and competences of graduates are of major importance to regional innovation systems in Europe (e.g. Hazelkorn and Edwards, 2019).

Moreover, universities may argue that their 'regional', 'domestic' or 'global' missions are intertwined; their regional engagement simply cannot be isolated from their other activities, goals, and ambitions. They may also argue that their organisational decision-making on how to distribute their scarce resources across these geographical domains is inevitably a trade-off between short-term economic constraints or strategic priorities rather than a matter of

longer-term, community-driven sense of civic responsibility. The degree to which universities are fulfilling their RII potential will remain unclear without detailed information on their RII potential, or clues as to the extent and nature of their RII capabilities.

RII can materialise in many ways and across varied timescales. Furthermore, RIIs are rarely isolated one-off events that can be easily traced back to a single source linked to a specific university. More likely, RII comprises a 'dynamic system' of chance events and randomness, of partial causality and loosely connected contributions. Not only is determining the causal attribution a challenging analytical undertaking, assigning any reliable valuation (monetary or otherwise) to such an impact is equally problematic. RII analytics and assessment will require a sophisticated 'smart' approach that takes these issues into account.

1.4 MODELLING A UNIVERSITY'S RII SYSTEM

Not surprisingly, meaningful and workable operationalisations of RII are still very much 'work in progress', whether describing their role in a university's engagement mission or gauging impacts of that same university in the local business sector. In 2018 we launched the notion of RII and introduced the first version of a conceptual and analytical mode (Jonkers et al., 2018). Further development requires more robust models, but above all an information and analytical architecture that can deliver relevant facts and evidence. Any convincing, high-quality RII analytical framework requires access to reliable empirical information, generally accepted measures of RII performance, user-friendly diagnostic tools, and ideally, automated 'track, trace and isolate' detection algorithms.

To get a grip on all these requirements, let us start with the foundation: empirical information on RII activities and outcomes. RII-relevant case studies have recently started to emerge, bringing specific or contextualised insights. A study by the European University Association (EUA) entitled '*The Role of Universities in Regional Innovation Systems*' presents case studies of nine universities in Europe each with empirical evidence of how these universities are integrated in the innovation system of their local city or region (Reichert, 2019). Adopting a university management perspective, the underlying analytical model of that study focuses on the role and contributions in six areas: culture of the system; human capital supply; knowledge production; other support structures (funding, services and infrastructures); organisational and regional strategies; processes; network communication channels and formats. The results provide interesting insights and methodological guidance on how relevant empirical information can be extracted from universities, their local partners and regional stakeholders. But it presents only one small sample of

universities and it applies one specific analytical lens. There are many more universities across Europe, and numerous other ways of studying RII and conducting an 'analysis' or an 'assessment' of RII achievements.[18]

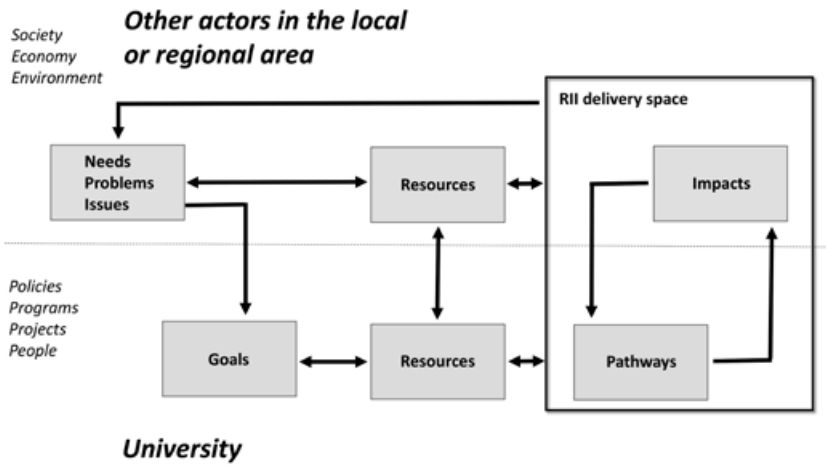
A large degree of divergence is to be expected among the thousands of public and private universities in Europe. The legislative, political, geographical, and socio-economic circumstances in which universities in Europe operate may diverge in several significant dimensions. The European higher education space comprises a heterogeneous collection of national systems that can be crudely classified into 'unitary systems', which are dominated by universities, and 'dual systems', where higher education institutions outside the university sector account for a very significant share of students (ETER, 2019). Operating within such systems, universities themselves are multi-input, multi-output organisations which may differ enormously in size, nature, and mission. Each university is the product of distinct historical, social, economic, and intellectual development processes and therefore defines its own organisational profile of teaching, research, or a broad range of other activities.

Although our above definition of RII is by no means comprehensive, it does contain several relevant features that enable us to explore the feasibility of a 'RII framework' which may help reduce the staggering complexity described above. The backbone of this framework should comprise an overarching 'Theory of Change' model (see section 3.2) as well as an associated analytical model that is specifically designed to collect and process RII relevant information. It should be a generally acceptable model that captures key features of observable realities and their dynamics. This means that elements of the RII definition need to be operationalised in a way that is recognisable and analytically feasible for universities. To begin with, let us focus on two core components of the RII definition: '… *processes and outputs* …'. This is a hotchpotch of facilities, activities and (intermediate) results – including all their interconnections and interdependencies.

Figure 1.1 presents a circular model with two main spheres (the university and its external environment), where universities influence actors in their local or regional environment and vice versa through a web of interconnected elements, flows, and feedback loops. Local or regional authorities are one of the key actors in that environment, who may articulate the RII-related socio-economic problems, command their own RII-relevant resources, and

[18] The distinction between 'analysis' and 'assessment' is important in this book: Chapters 1 to 8 are mainly concerned with analysis and analytical frameworks, whereas Chapters 9 to 11 turn to the use of the framework for assessment. By 'analysis' we mean a detailed description, monitoring or examination of RII relevant information; 'assessment' refers to judgement, appraisal or evaluation of that information.

exert steering effects on organisational goals and strategic objectives of local universities.



Source: Adapted from Jonkers et al. (2018); European Commission (2004).

Figure 1.1 General descriptive model of a university's RII system

This model describes a meta-level structure of links between different stages in the RII creation process and contributing factors. Acknowledging the fact that many universities tend to be an integral part of their immediate physical environment and spatial territory, we assume that this meta-model will hold, in varying degrees of accuracy, to any kind of university in Europe. The model seems 'closed' in so far as only the university and its local and regional environment interact with each other (involving several entities and at various levels). However, in reality it is merely a niche in a much larger 'open' socio-economic system operating at national or global levels. Figure 3.1 in Chapter 3 presents an enlarged version of the model where the broader geographic setting is incorporated.

The model also introduces the notion of an RII development trajectory; a transactional sequence of successive stages characterised by many 'non-linear' feedback-loops which reflect the complex dynamics of exchanges, interdependencies and interactions between and during the entire process from 'goal to impact'. Clearly, the directionality and intensity of these trajectories are very context- and time-dependent. RII delivery space variables may have non-recursive relationships (bidirectional causality) between parties or partners. This often makes them complex to navigate, which can result in high

rates of RII failure. The university consists of a 'RII-support architecture' with various facilities and infrastructures that enable RII pathways to generate RII. Depending on the circumstances, there could be very few pathways or many. To mention three such pathways: upgrading an educational curriculum to deliver employable graduates; launching successful start-up companies that create jobs and revenues in the local business sector; engaging in community outreach activities by students or staff that support local innovation-oriented events.

Our RII model also introduces the presence of an abstract 'RII delivery space', which straddles the university and its local environment and is affected by various interrelated resources that feed into it. Owing to non-linear processes and uncertainties in RII development stages this delivery space is characterised by outcome unpredictability. Gradual changes in an RII pathway, such as a new practical module in an entrepreneurship course for students, may lead to a sudden increase of university spin-off enterprises or start-ups.[19] Similarly, a specific case of successful RII may attract an unexpected flow of external funds that in turn may support existing RII pathways or create new ones. Monitoring the performance of RII pathways may therefore provide a useful indication of development trajectories towards achieving longer-term RII objectives.

Our model is specifically designed for such analytical purposes. However, first we need to be clear about what the various analytical concepts mean. Box 1.1 presents the terminology we apply throughout this book. A university's 'RII profile' is narrowed down to its 'Goals', 'Resources', 'Pathways' and 'Impacts' and is explicitly linked to the broader context of societal needs, problems and issues in the university's city environment or wider region. The presence of RII-relevant infrastructures, facilities, and other resources, comprises what we refer to as 'RII capacity'. Other resources may also contribute to generating regional innovation impacts, notably from external sources and partners in the region. Lacking sufficient empirical information, in many cases it will be unclear to what degree a university's current 'RII profile' can be adequately described and analysed according to the terms 'RII capacity' and 'RII capability'. We then apply a forward-looking perspective and use the general term 'RII potential' to refer to either capability or capacity. Looking backwards, we apply 'RII performance' to describe RII outcomes that directly relate to prior investments or activities of the university.

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[19] A university 'spin-off' firm is based on, or supported by, university-owned intellectual property; a university 'start-up firm' is founded and/or supported by a university but without IP ownership.

BOX 1.1 RII ANALYTICS TERMINOLOGY

Distinguishing the series of closely related general terms, we adopt the following definitions:

- RII profile: summary description of all RII-related information;
- RII portfolio: information on ongoing RII-related investments, activities, projects and programmes;
- RII capability: the ability to initiate or perform actions towards an RII relevant task or goal (an 'RII outcome' in the RII delivery space);
- RII capacity: the volume, size or quantity of resources or assets to pursue an RII outcome;
- RII competence: the state or quality of being functionally adequate to produce RII outcomes at the required or expected level(s) of performance;
- RII potential: having the capability and/or capacity to develop a future RII outcome;
- RII performance: observable and attributable RII outcomes.

1.5 ORGANISATIONAL DIVERSITY AND REGIONAL DIFFERENTIATION

Universities can produce significant value, as a primary source of knowledge, skills, and innovation, to their home regions. Most EU regions have at least one university within their territory, but the value depends as much on the university as on its local socio-economic environment. It also depends on how you define or delineate the geographical area (see Box 1.2).

BOX 1.2 DELINEATING A UNIVERSITY'S 'REGION'

Acknowledging and appreciating RII activities and objectives assumes shared understanding of what that 'region' actually is. Although a university is usually clearly defined and delineated, its region is not necessarily viewed the same by all relevant parties. Universities may see their 'region' as a functional interaction space, a highly dynamic area that is defined by physical proximity but also by changing opportunities. Depending on the circumstances, that flexible and ambiguous viewpoint may comprise of local, metropolitan and urban areas, as well as the surrounding rural area.

In contrast, local, metropolitan or regional authorities are likely to think in terms of a more static 'area of influence' based on a fixed spatial territo-

ry and associated administrative bodies. Different agencies may also have different definitions and boundaries, creating confusion within government.

Mismatches between the various viewpoints – either 'functional' and 'administrative' – may create misunderstandings between universities and authorities concerning a university's RII activities, goals and performance. RII analysis or assessment should deal with this issue on a case-by-case basis, and avoid implementing a detailed territorial delineation if the broad concept of 'region' serves no analytical purpose.

Universities can contribute to capacity building or expanding the demand side through new business formation, student enterprises, and graduate placements as well as encouraging staff to actively engage with local businesses. Universities can also make important contributions and offer a range of services to other sectors of society, especially health. The presence of a university makes cities and urban agglomerations more attractive places to invest and live. Academic staff and the student base of universities contribute to the overall diversity and vibrancy of the cities in which they are located. This is particularly important as the market for inward investment is becoming increasingly competitive, both in Europe and worldwide. Increasingly, regional governments and local authorities look upon their universities as high-value strategic assets, to be incentivised and exploited for further development of the city or region. A university's regional orientation and outreach activities can be highly organisation-specific and place-specific, depending on its organisational capabilities and strengths as well as obstacles and opportunities in the regional environment (Technopolis et al., 2012). The nature and intensity of a university's contribution is affected by 'scale and scope' effects on both the university's knowledge supply side, but also the regional demand side and how it is articulated (Kempton et al., 2013). In contrast to those universities located in Europe's state capitals or its major cities, universities in provincial capitals or secondary towns are often the largest employer in their urban area.

Universities not only contribute to the attractiveness of a region as a knowledge centre, since their connections with business enterprises and private sector organisations can also help create or support regional innovation systems. The responsiveness and absorptive capacity of the regional socio-economic environment plays an important role in determining the nature and level of those regional interactions and impacts (Edwards et al., 2020). In economically advanced regions, usually with more advanced innovation systems, there are greater prospects for knowledge transfer and exchange activities with R&D-intensive businesses. Knowledge-intensive business enterprises may significantly benefit from the presence of a critical mass of knowledge-generating universities within close proximity, which can

provide inputs essential to business sector R&D-based innovation processes (e.g. Boschma, 2005; Laursen et al., 2011).

Regional engagement and RII potential depend on the breadth and strength of connectedness, but also on framework conditions such as national legislation, regional support and funding systems, physical infrastructures, and the dynamics of the local innovation system. Geographical distance may also play a major role. The geography of innovation in Europe's larger nations is frequently skewed towards large metropolitan areas, or mega cities in some cases, thus introducing significant economies of agglomeration.

It is easier for graduates to find employment in places where government agencies, innovative firms and entrepreneurs tend to agglomerate (Feldman, 2001), in particular the densely populated areas of a capital city. Large universities in metropolitan areas have more options to develop a portfolio of regional activities than small universities in rural areas. Large cities, usually the home base of many universities, also tend to have sizable associated knowledge infrastructures, such as research institutes and science parks, which can ultimately develop into knowledge-intensive economic clusters and innovation hubs.

The further a university is separated from a country's economic or political centre, either the capital city or one of its regional hubs, the lesser the level of regional or national connectivity is likely to be, and the lower the potential for effective knowledge transfer, mobility and economic impact (Brown, 2016). This is particularly critical in the context of developing cities or regions that are struggling to create an innovation-supported development path. In those less advanced regions, which are often less densely populated and predominantly rural, the contribution of universities focuses on its 'human capital development' mission: teaching and training of students. Research activities are of lesser significance, or limited to developing research strengths in niche areas that are particularly relevant for local small or medium-sized employers and perhaps one or two major companies in the regional economy (e.g. Nilsen and Lauvås, 2018).

While a city or urban agglomeration might possess a university, or several universities, with sufficient RII potential there might be limited absorptive capacity within enterprises at close geographic proximity, especially among 'low tech' or services-oriented SMEs with no in-house R&D. Universities in such regions can contribute to capacity building or expanding the demand side, such as through new business formation, promoting student enterprises and graduate placements, as well as encouraging staff to actively engage with local businesses. Europe's 'regional universities'; those operating almost entirely within sub-national regional contexts, are also more likely to develop productive university–community engagements and responsiveness to needs of municipal or regional stakeholders (Benneworth et al., 2018). Regionalising

units will be expanding their activities within the local agglomeration – especially in the case of specialised, small universities that are heavily engaged with local partners.

A university's regional impact does not necessarily flow only from an exclusive orientation towards its home city or region. Given the increasingly important policy objective to stimulate inter-regional collaboration, RII analysis should also explicitly consider activities and impacts of universities beyond their immediate surroundings. Increasingly, many graduates and researchers at research-active universities have to be both globally functioning and locally connected. The 'global' research-active universities operating in international markets are less constrained by regional or domestic policies and are likely to continue developing along internationalisation paths. Some internationalising units at universities will step up their operations in the global arena, while remaining strongly rooted in their own national system. By virtue of their size and the centrality of their research and knowledge production roles, global research-active universities operate simultaneously in regional, national, and global environments. Universities with a global reach can be magnets of economic activity in the local environment. The extended geographical impact of universities, either nationally, in other parts of Europe, or even worldwide should be incorporated in contextualised analysis or assessment of their regional engagement and impacts.

2. RII analytical framework

2.1 THE ELEPHANT IN THE ROOM

An RII performance management framework could help to harmonise and optimise RII-related practices and policies. To implement such a framework, a university would need to have an 'RII process model' fed by reliable information to monitor activities and outcomes. University-wide RII implementation plans could generate a level of commitment needed to generate the economies of scale and scope with regard to RII pathways that could lead to a more active and successful pursuit of RII development options. Rather than being hampered by perceived organisational obstacles and/or potential risks for individual career development, a university could focus on opportunities the local environment may bring and develop joint aspirations (win/win objectives and shared advantages). The organisational responses, arrangements and strategies of universities, aimed at addressing expectations and pressures to become more locally oriented, will be varied. They depend in large part on opportunities with regards organisational configurations and capabilities, but also on funding structures as well as RII-oriented incentive structures and reward systems.

Most of the existing impact analytics and assessment methodologies tend to focus on knowledge exploitation activities and outputs, notably on the impact of academic research on business sector R&D and technological innovation, or on academic entrepreneurship and university spin-off companies. However, the potential impact of universities is much broader. The steady supply of human resources from local universities can be a key contributor to regional innovation systems. Universities can also play a role in providing entrepreneurial skills and thus foster the development of new innovative ventures. Teaching and training curricula at universities, as well as their academic scientific research, are increasingly designed to create long-term socio-economic impacts and societal benefits. Unfortunately, many of the university's socio-economic impacts and those wider benefits defy easy detection, comprehensive coverage, or systematic measurement. This is not surprising considering how interconnected universities and regions are and given the fact that they are all an integral part of a larger dynamic social system with a dizzying number of actors and a myriad of intangible interactions. So, we have

to face the major analytical challenge that is glaring at us, 'the elephant in the room': how to identify, describe and assess RII activities?

Developing an RII analytical framework that can capture at least some features and processes of that complex system is a very challenging undertaking. According to Markiewicz and Patrick (2016, pp. 1–2) such a framework:

- is both a planning process and a written product designed to provide guidance to the conduct of assessment functions (monitoring and evaluation) over the life span of an initiative;
- includes an overarching plan and a step-by-step guide to its operationalisation and application over time;
- defines the parameters of routine monitoring and periodic assessment that will take place;
- shows how quantitative data and/or qualitative information are collected, aggregated and analysed on a regular basis to support assessment processes and outcomes that address policy goals.

Any useful framework will put the university's mission portfolio at centre stage and contextualise its RII potential and performance within its local or regional socio-economic circumstances. The acceptability and usefulness of the framework will significantly increase if it complies with general principles and requirements described in Box 2.1.

BOX 2.1 GENERAL METHODOLOGICAL PRINCIPLES AND TECHNICAL REQUIREMENTS OF AN RII ANALYTICAL FRAMEWORK

Ideally the analytical framework should:

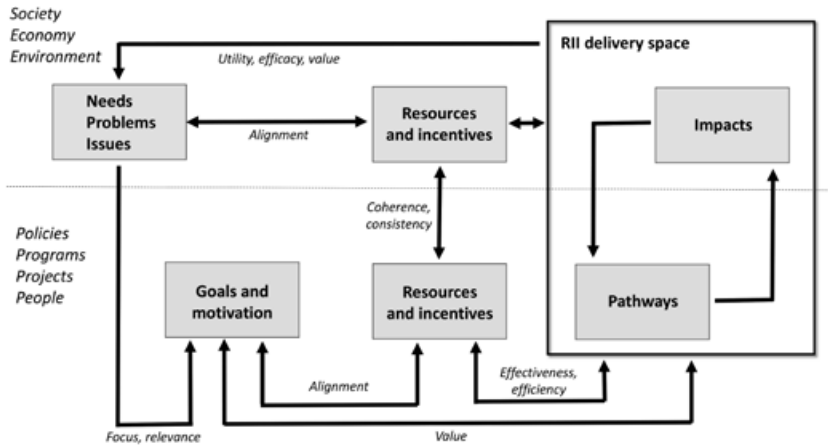
- be functional for all intended users;
- offer added value compared to other sources of information;
- deploy transparent methods, qualitative information ('narratives') and/or quantitative data ('numbers');
- provide information and data that are 'fact-based' (verifiable, empirical);
- adopt 'best practices' with regards to analytics, information gathering, measurement models, data definitions and data sharing, benchmarking and peer-learning;

- include acceptable performance indicators[1] – based on either qualitative information ('narratives') or quantitative data ('numbers');
- focus on innovation outcomes rather than simple quantity of engagement;
- incorporate general 'background' information as well as university-dependent and region-dependent 'foreground' specificities;
- offer opportunities to develop and implement customised information sources and indicators for specific needs of producers (universities) or users (stakeholders, funders, others); and
- have a well-designed governance structure that contributes to learning within the university in question as well as others.

But what defines the boundaries of the possible? Clearly, the availability of empirical information presents a formidable hurdle. Any RII analytical framework will be clearly handicapped by the lack of such information, or its questionable validity and relevance. The more sophisticated the framework, the scarcer the useful information and statistical data becomes. Systematic, comprehensive frameworks are indeed doomed to fail as diagnostic devices – if only because the highly-anticipated end product, the regional innovation impact, tends to be a shape-shifting and elusive outcome that may or may not emerge somewhere down the line. It could take years before any clearly identifiable impact materialises. By then it would be hard to establish the provenance of that particular effect or benefit, let alone attribute it to a specific source within a university. Sometimes, one can trace an impact back to a single 'make or break' event, such as the first publication about a scientific discovery or patent application of a breakthrough technology. In most cases, the timeline and causality are unclear and impact will often be generated by complex interplays of many sources and (hidden) determinants. Retrospective studies of RII trajectories may reveal that chance and randomness played a decisive role.

How to design an empirically feasible analytical framework of RII performance in the face of such uncertainty, ambiguity, and missing information? Analysts and policymakers will have to grapple with the inevitable trade-offs: between accounts of the 'now' and views of the 'possible future', objectivity and subjectivity, detailed accounts or panoramic overviews, between measurement and opinions. The graphical presentation of the RII model, presented in Figure 2.1, provides guidance. It shows that assessments of the 'RII delivery space', as presented in that graphical overview, is merely the tip of the iceberg

[1] Indicators are indirect measures of phenomena or objects that cannot be measured directly. These proxy measures can be employed to assess RII model components or achievements that are of an abstract nature or comprised of attributes that are difficult to operationalise unambiguously.



Source: Adapted from Jonkers et al. (2018); European Commission (2004).

Figure 2.1 Analytical model for RII analytical framework

and that the whole RII system will have to be reflected in the assessment in one way or another. The bottom section of this figure features general characteristics of RII system performance that can be monitored and assessed if the right kind of information is made available on its key components. The analytical model represents an 'RII value' oriented approach, emphasising discernible impacts on end users and gauging its value relative to the investments made and needs that are addressed. Operationalisation of the concept 'value' will vary; be it 'value for money', 'societal value' or something else, and depends on RII policy goals, organisational objectives or universities and many other factors.

How to assess the various dimensions of 'value' as well as other RII performance parameters such as 'efficiency' and 'relevance'? Relationships between RII supply and demand, the primary determiner of 'value' are often not straightforward, because the availability of new resources and knowledge can change the conditions of 'demand'. How to incorporate such dynamics? While collecting empirical evidence on impacts will largely rely on engagement narratives and showcasing, evidence on RII capacity seems much more amenable to measurement and quantitative performance indicators. In both cases, university-specific indicators and additional qualitative information will be needed to compile a sufficiently broad and in-depth RII profile of each university. Only then will the analytical framework be sufficiently developed to assess the interactions and connections between universities and their regions as well as their impact on innovation systems.

Such an analysis or assessment can be 'formative' or 'summative'. Both can be part of organisational learning processes. The summative view is often backward-looking, focusing on past performance and achievements, and on whether and how goals or expectations have (not) been reached (see section 9.2 for further information on formative and summative approaches). The results feed into strategic decision-making or resource allocation. The formative approach tends to be forward-looking, focusing on possible opportunities or likely threats; outcomes of such assessments may serve as management input for strategic development or longer term organisational trajectories.

2.2 GATHERING FACTS AND EVIDENCE: INFORMATION AND INDICATORS

Availability and access to 'qualitative' information and 'quantitative' data – sourced either from the university itself or from elsewhere – is of paramount importance for any workable RII analytical framework. Preferably it is easily accessible with meaningful, up-to-date and verifiable information. What kind of evidence-seeking indicators-based approach can be safely deployed for an up-to-date RII analytical framework? Is there any way of collecting or presenting information and data that is sufficiently reliable and robust? What kind of disclaimers need to be in place?

The origins of an RII may stretch back many years. Given that retrospective nature, RII analysis and assessments will necessarily involve historical information which may suffer from validity issues due to incomplete evidence, non-verifiable supporting documentation or selection biases. Retrospective narratives are geared towards the showcasing of success stories which allow us to recognise, with hindsight, RII successes and hopefully also identify the success factors that made the difference. Selective showcasing of 'regional impact stories' presents a format to convey key evidence framed within an organisational context and regional backdrop. There is a downside: information on obstacles, constraints or unfortunate circumstances that prevented RII from occurring are likely to be buried and lost for further analysis and organisational learning. Near-successes, let alone dismal failures, are often left out of the limelight. So, it is fair to assume that a significant share of RII-relevant information will be either missing, incomplete, outdated or non-verifiable. Although the use of narratives offers a qualitative sense, it also underscores the grave limitations of comparability, both across different cases within a university and across universities. Narrative-based 'qualitative' performance indicators are less suited for comparative purposes.

If accurate and valid information is out of reach for a full-blown RII assessment, we can search for proxies – the second-best option. Such 'indicators' do not always provide an accurate measure of an underlying phenomenon; hence

due caution is required in analytical settings. Some indicators are probably misleading irrespective of their contexts, others could even be fundamentally flawed in particular circumstances. It is therefore important to be very clear about the limits of indicators: they will never cover all relevant dimensions of RII resources, pathways or performance.

Unsurprisingly, there are currently no agreed-upon indicators to gauge the RII potential of a university, let alone RII performance. 'Quantitative indicators', which are those relying exclusively on measurement and 'numbers', introduce a considerable risk of misrepresentation and underreporting. Even if measurements and quantitative indicators are only used as support tools to inform, enrich, or improve RII narratives we still need to be aware that numbers are a powerful messaging device in a narrative. Such performance measures impose a focus on those few components of RII capacity, impacts and spill-overs that are relatively easy to identify, categorise and measure. Relying on metrics tends to throw us back to crude, linear models because non-linear processes and flows are often beyond measurement. Numbers require context; it needs to be clear what they reflect or may signal.

BOX 2.2 MULTIRANK INFORMATION PLATFORM

U-Multirank's 2019/2020 edition consists of seven 'Regional Engagement' performance indicators:

- Income from regional sources;
- Student internships in the region;
- BA graduates working in region;
- MA graduates working in region;
- Graduates employed in the region;
- Strategic research partnerships in the region;
- Joint research publications with industrial partners located in the region.

The quantitative data for indicators 1 to 6 are based on self-appraisal reported information from each university; the numbers for indicator 7 derived from computations on information in international bibliographic databases.

The U-Multirank webpage[2] contains more information on each of these indicators.

[2] See U-Multirank webpage: www.umultirank.org/about/methodology/indicators/.

There are no readily available numbers on RII performance of individual universities. Fortunately, we are not entirely empty-handed as far as publicly accessible data is concerned with some bearing on RII. The online platform *U-Multirank*, one of the major ranking systems of universities worldwide, contains eight metrics-based, quantitative indicators that offer a baseline for measurement of RII-related performance (Box 2.2). The broad scope of these indicators, which cover education, research and employability, enables an evidence-based analysis of some aspects of a university's 'RII profile'.

U-Multirank's coverage of higher education institutions includes hundreds of universities in Europe or other higher education institutions. Not all registered universities are able to provide the requested information for each 'regional engagement' indicator. There is a substantial degree of missing data. As a result, the level of coverage across all U-Multirank registered universities tends to be 'moderate' in the case of the first six indicators. The last indicator provides 'complete' coverage, at least for those universities with a sufficiently large volume of research publication output. Each of these indicators can be useful to supplement an RII narrative, but also to provide an average performance level across universities. Take for example the share of 'BA graduates working in the region'. Selecting data from the U-Multirank's 2019 edition and those universities located within the EU27 (excluding the United Kingdom), this source provides data for 105 universities. Selecting the measurement year 2019, and surveying those who were students in 2015–2017, the share of BA graduates who found employment in the region was on average 64%. The statistic for MA graduates (also for 112 universities) was 59%.

Another example, 'Regional publications with industrial partners', comprises a much larger set of universities in the EU27. All these 590 organisations are 'research active', having produced at least 50 research publications in international scientific journals. The 'region' is clearly demarcated as a 50 km radius around the university's city of location. Any co-produced research publication with an R&D partner from the business sector within this area is classified as regional. The average share of such regional co-publications, within all co-publications the university produced with the business sector, is 23%. Many universities with strong R&D ties to local industry tend to have shares of 30% or more (Tijssen, 2019).

U-Multirank indicators also invite direct comparisons across universities, but closer examination of definitions and operational parameters is required to assess the true relevance of these indicators for RII analysis, monitoring or assessment. Organisational comparisons and benchmarking can only be done with a reasonable degree of confidence if clear and convincing arguments exist as to why such an indicator reflects a feature that is sufficiently applicable or desirable in every university and region under investigation.

2.3 NARRATIVE WITH NUMBERS

Shifting the analytical perspective, as much as possible, from past performance to the current situation solves some of the above-mentioned issues that may undermine the informational value of RII indicators. A focus on the current RII resources and pathways (such as supporting structures, processes, and communication channels) opens up possibilities to gauge the likelihood of future RIIs. Where narratives supply high-quality 'downstream' RII information, well-chosen indicators of RII pathway characteristics may be able to describe the 'upstream' potential to create such impacts but perhaps also possible opportunities or obstacles lurking behind the data. Moreover, RII capacity tend to be more amenable to measurement and aggregate-level comparability. There are several options for quantitative indicators, for example: graduate employment rate, sources of external income, R&D cooperation contracts, students in entrepreneurship courses, number of university spin-off firms that have survived for five years, or resources spent on implementation of regional smart specialisation strategies. Selecting a suite of indicators, the resultant RII profile is likely to be representative of a university's general performance.

Synthesising these considerations and constraints boils down to three methodological principles that should drive 'smart' evidence-informed RII analysis and assessment:

- focus on up-to-date and reliable empirical evidence: collect qualitative and quantitative information on current RII resources and RII pathways (RII capacity) rather than on RII achievements;
- design and apply appropriate indicators: select only a limited number of broadly accepted proxy measures ('performance indicators') that reflect relevant attributes of the entire RII competence profile;
- contextualise the findings for meaningful interpretation and conclusions: assemble narratives and case studies that further describe and explain that RII competence profile, presenting regional background information but also organisational success factors and organisational obstacles.

Although metrics-based 'quantitative indicators' tend to carry a greater degree of objectivity and comparability, they come with various caveats in terms of validity, reliability and relevance. In view of the fact that several (potential) impacts can only be captured with qualitative information, rather than indicator-based statistical data, this three-pronged 'narrative with numbers' analytical framework presents a viable compromise between what we would like to have (in the ideal 'information on everything' world) and what is actually feasible given all the practical constraints we simply have to accept when studying a complex social system. This multi-method, multi-source approach

has several advantages over purely qualitative case studies as they allow for a greater degree of objectivity, comparability and tracking of progress over time.

A narrative supported by indicators is a more appropriate analytical format to identify, categorise, interpret, and explain. To do so, the narratives must go beyond the numbers and should be more comprehensive. Ideally, narratives can be cross-checked and verified by independent sources. If numbers are used to help develop or substantiate narratives, their narrowness is not much of a problem; they illuminate some areas better than others. But even then, using such 'hard' performance indicators for RII policy purposes is always controversial, not only given their inherent limitations as proxies, but also because of the debatable nature of the associated policy goals. The inevitable tension between 'what is needed' and 'what is feasible' will have to be navigated. Regional innovation impacts can take years to materialise. In some very exceptional cases, they emerge quickly and are clearly visible, and the causal chain of events is easily established. These showcases can really bring home the message. However, in most other cases the 'signal' is weak and the causal relationships even weaker. The observed 'hard' empirical evidence captured in numbers might prove to be less robust or reliable than required, and thus the narrative is less convincing.

Neither 'quantitative' nor 'qualitative' are the perfect solution for an RII analytical framework, but a 'narrative with numbers' seems a satisfactory solution. However, this approach pushes some methodological boundaries into unchartered territory. It seems well-suited for purely descriptive purposes, and as an information filter 'heuristic', but could it also work as the empirical foundation of an RII analytical framework? Quantitative indicators need to be explicitly associated with RII characteristics of universities that are theoretically relevant, important for policy purposes, or both. Moreover, to turn an indicator into a performance measure is a very important decision from a management perspective and needs to be adequately supported. This is not a minor leap and would require a discussion of the performance criteria and associated characteristics that need to be promoted within universities, and how these elements map across the proposed performance indicators.

Even more challenging is the connection between RII assessment and funding decisions. It is not the same to develop a panel of indicators to provide a support for, say, aggregate analysis across universities or as a core component of a formula-based funding mechanism. The latter is especially problematic as it requires near-perfect alignment between RII policy objectives and the expected outcomes or impacts. As universities tend to 'chase the indicators' the effects could predictably gravitate towards 'what you measure is what you get'. Moreover, performance indicators for an RII funding formula should, in principle, be appropriate for comparative measurement. This means

that the indicators are not influenced by the different contexts in which they are applied: regardless of context a higher value in an indicator would reflect, say, better performance. This is a tall order to achieve. Many of the traditional RII-related indicators, such as the number of spin-off companies produced by a university, respond to differences in the dynamics in regional business sectors or constraints imposed by national regulatory regimes.

Despite these pitfalls and caveats, our 'narrative with numbers' approach should prove applicable within and across the large variety of universities in Europe when guided by very cautious applications of its indicators, ensuring a robust mix of relevant information, and offering adequate opportunities for appropriate contextualisation. The framework's potential for real-life usage was tested in a series of case studies conducted in 2018 and 2019 among more than 20 research-active universities in Europe. As described in more detail in Part II, this pilot project offered valuable insights and lessons; not only to gauge the acceptability of the RII concept, but also on the feasibility of implementing that concept, and its four main analytical dimensions, in analytical settings and self-appraisal reporting by universities. All in all, the 'narrative with numbers' model seems useful for revealing the role of these universities in their regional innovation systems far beyond the information that numbers and rankings can offer. This reporting format allows organisations to both contextualise their performance – either within the context of a region's absorptive capacity and/or the university's vision, mission, and strategy for its contributions to the region's socio-economic development. Either way, it is important to look at the 'bigger picture' as presented in the next chapter.

3. The bigger picture

3.1 REGIONAL, NATIONAL AND INTERNATIONAL FACTORS

The (possible) RII performance of a university depends on the regional innovation system in which it operates. Any RII activity or pathway will be shaped and driven by a mix of local circumstances, regional infrastructures, opportunities and conditions for experimentation, knowledge creation and learning processes, and useful outputs for socio-economic development. Connectivity between universities and regional actors is a key RII parameter. Universities will tend to shape RII-creating activities and strategies based on a mixture of: interdependent inputs and processes; internal organisational characteristics and priorities; external, homogenising forces such as (inter)national HE policy frameworks and regulations; requirements and expectations from local or regional partners and stakeholder networks (Benneworth et al., 2015). Strong local links between the 'triple helix' of the higher education sector, the business sector, and government authorities is now generally seen as one of the common conditions for a successful regional innovation system, where civic sector actors can be included as part of the 'quadruple helix' configuration.[1]

But universities are also shaped and driven by factors beyond the local or regional environment. Think of international students, funding from national government, or global research networks. National stakeholders or international funders play a role in the core functions and strategic missions of universities, and the governance models they deploy to engage with local or regional development priorities (Goldstein, 2010; Laursen et al., 2012; Pinheiro et al., 2015). The national or international dimension may dominate over the local or regional one.

[1] Theoretical and conceptual models that focus on the role of HEIs in science-innovation systems include the Mode 2 model (Gibbons et al., 1994), Triple Helix model (Etzkowitz and Leydesdorff, 1995) and Quadruple Helix model (Carayannis and Campbell, 2009; 2012). The latter model incorporates a new type of 'civic society' actors; students, consumers, citizen groups, and the general public, who interact and cooperate with the 'triple helix' of universities, business enterprises and government organisations.

Although regional innovation processes are spatially embedded and geographically dependent, the underlying complex social systems are characterised by all sorts of 'push and pull' flows, interactions and interdependencies between individuals and organisations. Moreover, these relationships and connections do not stop at local or regional borders. Figure 3.1 exhibits a simplified, stylised diagram of a networked complex system, where the university's involvement in the regional innovation system interacts with the national or global environment where, for example, goals and resources for scientific research projects are set in collaboration with partners outside the local region.[2] International projects or national networks may not only generate a range of regional innovation impacts, but also create spill-over effects and benefits elsewhere in the home country, in Europe, or even worldwide.

Large research universities in Europe also tend to act as 'hubs' or 'system integrators' within their local or regional knowledge infrastructures, connect-

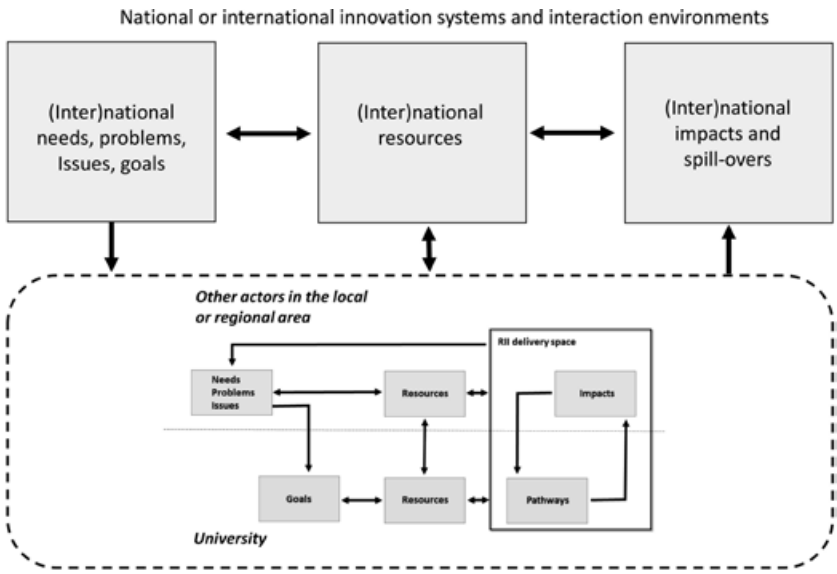


Figure 3.1 *National and international dimension of a university's RII system*

[2] In the smallest EU Member States (such as Luxembourg and Malta), the national and regional dimension are equivalent entities in the NUTS classification system (NUTS1 and NUTS2 regions).

ing them with the national and international levels. They attract and retain people and other resources, and all the associated services that emerge, which overall creates a more dynamic environment. This effect arises from positive agglomeration processes: in order to benefit more effectively from university resources, such as knowledge sharing with academics, R&D-intensive business enterprises and research institutes, other higher education institutions, but also vocational training institutes are more likely to move to cities with such universities or expand their operations. Localised 'knowledge spill-overs' and economies of agglomeration are key determinants within innovation-enhancing local environments (e.g. Breschi, 2011). Universities with an industry-aligned research specialisation profile have a much higher chance of successfully engaging with the local business sector.

3.2 THEORY OF CHANGE

Creating impacts and spill-over effects implies noticeable change – both on the side of the cause (contributor) or the effect (recipient). Some impacts and changes occur by chance and were unintended, others are by design and desired. To determine whether or not an RII analytical framework makes any sense, as part of a policy steering mechanism, we need to develop a '*Theory of Change*' (ToC) methodology. An explicit and actionable ToC can guide the design of coordinated RII policies and strategic plans, as well as the design of a customised RII analytical framework. Such a ToC states feasible goals and identifies necessary initiatives or preconditions. It also identifies the implementation of intermediate steps leading to a specific outcome that should ultimately cumulate in a series of short-term, intermediate, and longer-term RIIs. Those cause/effect chains and pathways are, ideally, explained by rationales of why one stage in the process is thought to be a prerequisite for another. ToCs specify trajectories and underlying processes that lead from resources to impacts, a road map of actions a university should take to achieve RII-related goals.

Adopting a ToC for policy guidance implies explicit steering effects. It requires organisational actors and stakeholders to specify and model the desired and anticipated impacts before they decide on forms of initiative or policy interventions to achieve those outcomes. Which raises the key question: what can be steered, and what are those targeted or expected outcomes? That depends on the perspective. Focusing on the universities, a distinction should be made between 'generic' ToCs, which apply across a range of universities, and 'institute-specific' ToCs that show how a university can organise itself to create and achieve desired changes and targeted RIIs.

Moreover, the various policy environments in which universities operate are embedded in three higher-level 'system conditions': (a) national or federal reg-

ulatory and legal frameworks, (b) socio-economic and political structures, and (c) higher education governance systems. Each of these interconnected conditions is driven by its own needs, problems and issues that affect RII-related policy formulation and implementation. As an example of possible policy steering processes and external interventions, Figure 3.2 presents a 'generic' system-level version of the arenas, actors and actions a university could take to improve its RII performance. This particular logic model[3] is 'non-linear' – it includes two explicit feedback loops ('adjustments') to capture and implement learning effects. There could in fact be many more 'minor' adjustments within and between the various steps in this process. The policy implementation will comprise funding mechanisms and resource sharing, embedding associated legislation and regulations. When looking at Europe, and the EU in particular, one can observe a wide range of policy initiatives and ToCs designed to promote regional engagement and economic development. Some of those ToCs are implicit and embedded in local 'bottom up' initiatives, others apply very explicit ToCs and are driven by (supra)national 'top down' policy interventions.

Figure 3.2 Hypothetical example of a university's RII-related logic model: key actors and key actions

[3] Where a Theory of Change specifies and explains assumed or tested causal links between inputs, processes, outputs, outcomes and impacts, an associated 'logic model' or 'action model' describes or depicts the logical sequence of those connections or actions.

In order to identify, classify and assess a university's RII profile, it is crucial to understand how universities may shape or affect those regional innovation systems. Supplying the ToC or logic model with relevant information on (most likely) causes and effects, entails a firm grasp of a university's RII capacity and the chances of generating RII. Organisational missions and activity profiles are key contributing factors. Over the years a significant number of studies have been conducted, mainly in Europe and the United States, on regional impacts of universities, usually the economic impact of individual universities. About 25 years ago, a study by Harvey Goldstein and his colleagues identified eight interconnected functions of modern research-active universities that may lead to regional economic development and impacts (Goldstein et al., 1995):

- creation of knowledge;
- human capital creation;
- transfer of existing knowledge and know-how;
- technological innovation;
- capital investment;
- regional leadership;
- influence on regional environment;
- knowledge infrastructure production.

Professor Goldstein and his co-worker Catharine Renault, both then at the University of North Carolina, were among the first to develop a model for RII analysis and assessment (Goldstein and Renault, 2004). In that study, which collected data on average earnings of university graduates across 312 metropolitan areas in the United States, they found that the 'research and technology creation' function generated significant knowledge spill-overs that resulted in enhanced regional economic development which would otherwise not have occurred. More importantly, they observed that this function's contribution was small compared with other functions. Which of the other functions will have a much larger regional impact is unclear. Although teaching and training (human capital creation) is a very likely candidate, conclusive empirical evidence of regional impact is still largely lacking (Valero and Van Reenen, 2019; p. 66).

Overviews and reviews of similar types of studies can for example be found in Drucker and Goldstein (2007). Several academic studies have hypothesised, or empirically unravelled the main organisational functions and associated RII resources and pathways. A host of studies and related policy reports have appeared in recent years on the regional impact of universities (e.g. Technopolis et al., 2012; Edwards et al., 2020). The EC-commissioned EUniVation study, on measuring the contribution of universities to innovation through education, proposes a number of metrics that can be used for assessing

the (potential) economic impact of universities with regards to their teaching and training activities (European Commission, 2017a). As for the practical utility and validity, a subsequent study of three selected indicators (media appearances by staff and students, third mission policies, and budget for outreach activities) proved each of them suitable for the societal engagement functions under consideration (Benneworth and Zeeman, 2018).

The HEInnovate initiative, a parallel development in Europe, provides an indicator-based tool specifically designed for universities worldwide. It has proven to be a useful 'peer learning' tool for university management, enabling them to explore and compare their entrepreneurial and innovative potential. The online self-assessment module distinguishes eight 'areas': Leadership and Governance; Organisational Capacity; Entrepreneurial Teaching and Learning; Preparing and Supporting Entrepreneurs; Digital Transformation and Capability; Knowledge Exchange and Collaboration; The Internationalised Institution; and Measuring Impact. Each area comprises a series of individual statements that prompt answering on a scale from 1 to 5. The 'Measuring impact' area is interesting for the purpose of this book, although there is no mentioning of the university's 'region' or any other surrounding territory. The six statements in this particular area are:

The university regularly assesses …
… the impact of its entrepreneurial agenda;
… how its personnel and resources support its entrepreneurial agenda;
… entrepreneurial teaching and learning across the institution;
… the impact of start-up support;
… knowledge exchange and collaboration;
… the institution's international activities in relation to its entrepreneurial agenda.

Although HEInnovate tends to apply a narrow focus on a university's entrepreneurial agenda, it emphasises the importance of periodic monitoring and as an analytical tool to help understand aspects of its organisational performance and strategic management with regard to innovation impact. Unfortunately, HEInnovate does not help users to self-assess the 'how, where and why' of RII potential or RII pathways, but its various areas and statements do offer guidance as to which general characteristics are relevant components in an RII analytical framework.

Synthesising and summarising the above sources, we grouped most of the RII relevant functions into four large 'RII portfolio domains' that may exist within universities to create, support or enhance its regional innovation impact:

- Regional orientation, strategic development and knowledge infrastructure;
- Education and human resources development;

- Research, technological development and knowledge transfer;
- Support to enterprise development and entrepreneurship.

The RII resources, activities, and pathways in these four domains may help to identify important factors within the university, and its home region, to better understand how a university's (tapped or untapped) RII potential may evolve into RII success. Naturally, these broad domains will partially overlap, interact, and perhaps also reinforce each other. The scale, scope and RII potential of these four domains will differ in each university and may change over time. Some domains, notably 'education and human resources development', will have a relatively large impact in the local socio-economic environment or spill-over effects in neighbouring regions, whereas 'research, technological development and knowledge transfer' may have national or even international impact in business sectors (Valero and Van Reenen, 2019).

Chapters 5 to 8 in Part II of this book elaborate on each of these four domains, presenting illustrative information on the RII potential and RII performance from RII self-reporting by universities in Europe.

PART II

RII case studies

Evidence-based RII analytics and assessment needs to be properly grounded and contextualised with relevant empirical information and reliable data. We can only interpret regional engagement activities and RII performance when all important facts and figures are sufficiently clear and understood. The RII model and analytical framework, both introduced in Part I, provide conceptual and analytical guidance, but determining the practical feasibility of our approach requires 'proof of concept' testing. Our pilot study was meant to gauge the framework's potential for RII self-appraisal reporting by universities, but also provide a possible tool for external analysis and assessment, as well as general guidance for developing a system of RII indicators.

Part II describes those studies and summarises the main findings. Its five chapters present a general overview from the perspective of 20 selected research-active universities in Europe – all of which are regionally engaged universities. Their RII profiles and portfolios are presented and discussed. Our observations present valuable insights into the how, where, and why universities are engaging, interacting and collaborating with their region.

Chapter 4 introduces the 20 universities that submitted RII self-appraisal reports. Taking a closer look at a subset of those universities, we present information on their RII capacity gathered through a dedicated questionnaire. The survey findings clearly indicate their commitment to regional innovation engagement, but also reveal where universities experience challenges to implement their RII ideas and aspirations. The information from each university is structured around the 'RII portfolio domains' within their engagement profiles. The four domains that were introduced in Part I are: (i) regional orientation, strategic development, and knowledge infrastructure; (ii) education and human resources development; (iii) research, knowledge creation and technology transfer; and (iv) support to enterprise development and entrepreneurship education. The final section presents an analysis of those self-appraisal reports from the viewpoint of RII indicators.

Chapters 5 to 8 further unfold the collection of self-appraisal reports by providing a summary overview of RII activities and achievements in each of those four domains. Framed within two main components of the RII model – 'RII resources' and 'RII delivery space' – these overviews illustrate the variety of RII profiles among these universities and how they engage within their local and regional environments.

The general aim of the pilot studies described in this second part of the book was not so much to gain a full insight in the way that universities contribute to, and impact on, their regional innovation ecosystems, but to find out and understand what type of RII-relevant information they are able to provide in the context of organisational self-appraisals. Chapter 9 in Part III will engage in a critical reflection on the nature of this material in order to draw lessons for the further development of an analytical framework aimed at assessment applications.

4. Case studies of universities in Europe

4.1 RESEARCH DESIGN AND SELECTED UNIVERSITIES

In our general model of an RII system and its derivative RII analytical framework (presented in Part I of this book as Figures 1.1, 2.1 and 3.1) we try to 'square this circle' in an abstract manner. Moving into the realm of empirical information gathering and obtaining evidence, we need to recognise that each European university, embedded in its local region, defines its own unique system of assets, resources, opportunities and obstacles. How to capture such diversity, dynamics, and uniqueness? Not only with regard to the RII potential and performance of each university, but also regarding background information and the local socio-economic circumstances in which it operates. Capturing the complexity of those RII systems and getting to grips with relevant attributes, such as RII pathways, begs several questions. To what degree does the model represent RII realities within universities? Can the RII analytical framework deliver? Is it sufficiently versatile to collect a wide range of relevant information?

The only way to convincingly answer the above questions is to put the analytical framework to the test. We applied an analytical framework consisting of the four RII portfolio domains and main components of the RII analytical framework (see Box 4.1).

BOX 4.1 DESCRIPTIVE FRAMEWORK FOR THE SELF-APPRAISAL REPORTS: RII DOMAINS AND MODEL COMPONENTS

RII domains:

A. Regional orientation, strategic development and knowledge infrastructure;
B. Education and human resources development;
C. Research, technological development and knowledge transfer;
D. Support to enterprise development and entrepreneurship.

RII model components:

1. Needs, problems and issues articulated by external parties in the local or regional environment;
2. Organisational goals, internal driving forces and/or motivational factors within the university;
3. Resources, general facilities and/or incentive systems within the university;
4. Pathways, outreach and engagement connections between the university and outside agents;
5. Delivered impacts (RIIs) by the university;
6. Relationships between RII initiatives, capacities, and competences within the university and those in its home city or region.

Our information was extracted from two sources:

- A mail questionnaire we distributed across 20 research-active universities and 13 countries in the EU28. We asked about their RII capacity, capabilities, and challenges. The survey's seven questions address the RII model components 2 and 3 listed in Box 4.1. Section 4.2 describes this questionnaire in more detail and presents the survey's main findings.
- We enrolled a selection of universities in Europe to conduct their own RII self-appraisal reporting on their RII profile. Each were invited by the European Commission's DG Joint Research Centre (JRC) to participate in this pilot study and submit a 'narrative with numbers' report, according to specific instructions described in Appendix A, that summarises relevant information on their past RII achievements, current RII potential as well as their vision and plans for the near future. These cases studies, conducted in 2018, were primarily designed as a mutual learning platform and to help us gauge the feasibility and utility of the framework.[1]

The questionnaire and case study approach provide a rich view of RII-relevant issues from different angles. Although the collected information is incomplete, and possibly biased, the evidence is valuable for testing the analytical strength of a structured 'narrative with numbers' approach and the way it could be implemented as an RII self-appraisal reporting tool.

The universities that took part in this study were approached after presentations of the RII framework at events and meetings organised by relevant

[1] The universities may have used this opportunity, without our knowledge, to engage in more detailed assessments for their own internal purposes.

working groups of the European University Association (EUA),[2] CESAER[3] and ECIU.[4] The participating universities were brought together with regional government agencies, European Commission officials and representatives from the EUA, CESAER and ECIU in four events: two in Brussels, one organised by Aalborg University and another organised by the University of the Basque Country. These events facilitated mutual learning in the drafting of the case studies and a further reflection on the RII analytical framework. Universities were also supported by JRC researchers through the review of (draft versions of) submitted case study reports.

Their participation in those case studies was voluntary. This imposed some constraints on attaining an optimal geographical coverage. For example, no universities are included from some large European countries such as Germany or France. The reason for this is that either no interested university was identified among the membership of the university associations, or because the participating universities withdrew at a later stage in the development of their case studies. In spite of these constraints the sample of participating universities includes universities from the South, East, North and West of Europe; and from regions at different levels of economic development and absorptive capacity. The sample also includes different types of universities:[5] comprehensive research universities such as the Catholic University of Leuven, Leiden University and Bologna University; leading technical research universities such as the Technical Universities of Turin, Milan, Catalunya, Delft University and the University of Strathclyde; young innovative universities such as Aalborg and Aalto universities and universities with an explicit regional orientation such as Rovira i Virgili University, the University of the

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[2] The European University Association (EUA) represents more than 800 universities and national rectors' conferences in 48 European countries.

[3] The Conference of European Schools for Advanced Engineering Education and Research (CESAER) is a research stakeholder organisation comprising 53 specialised and comprehensive universities of science and technology in European countries (www.cesaer.org).

[4] The European Consortium of Innovative Universities (ECIU) is a network of 14 relatively young universities who are strongly committed to the encouragement of innovation and entrepreneurship, with close ties to industry in their region and a focus on innovative teaching approaches.

[5] The classification of university types is fluid, in part because of the current state of conceptual development in the studies of these organisations. For example, there is no agreed upon definition of an entrepreneurial university: the Catholic University of Leuven could be classified as both a comprehensive university; a technical university as a member of CESAER given its strong engineering capabilities; a 'glocal' university with a strong impact on both the high tech region it operates in as well as being very successful at the global stage; while it also incorporates some elements of what could be understood as an entrepreneurial university.

Table 4.1 European research-active universities participating in the case studies

		ISCED 5–7 graduates (count)[1]	Research publication output (count)[2]	Regional Innovation category[3]
University of Bologna	Italy	18833	16757	Moderate
Catholic University of Leuven	Belgium	14563	24823	Strong
University of Warsaw	Poland	13255	6703	Moderate
Technical University of Milan	Italy	11796	7864	Moderate
University of the Basque Country	Spain	7976	9104	Moderate
Norwegian Univ. of Sci. and Techn.	Norway	7847	10055	Leader
Leiden University	Netherlands	7495	16442	Leader
University of Strathclyde	United Kingdom	6885	4952	Strong
Technical University of Turin	Italy	6466	4691	Moderate
Eötvös Loránd University	Hungary	6442	3666	Moderate
Aalborg University	Denmark	6169	6973	Strong
Technical University of Catalunya	Spain	5818	6627	Moderate
Delft University of Technology	Netherlands	5203	10797	Leader
Aalto University	Finland	3968	7351	Leader
University of Trieste	Italy	3373	4731	Strong
University of Aveiro	Portugal	2924	6265	Moderate
Rovira i Virgili University	Spain	2751	3677	Moderate
University of Stavanger	Norway	2474	1911	Strong
Kaunas University of Technology	Lithuania	2378	1413	Moderate
University of Ruse	Bulgaria	1844	44	Modest

Sources: [1] ETER database (August 2019). ISCED 5–7: undergraduate students ('Short-cycle tertiary education', 'Bachelor or equivalent', 'Master or equivalent'). Data reference year is 2016; [2] Web of Science database (Leiden University); U-Multirank 2018 data (publication years 2013–2016); [3] Regional Innovation Scoreboard 2019; 'Performance Group' data (https://ec.europa.eu/growth/sites/growth/files/ris2019.pdf).

Basque Country, University of Trieste and the University of Ruse. A full overview of the participating universities is provided in Table 4.1.

As a whole, these two information sources provided a valuable overview of RII ambitions, competences, activities and achievements. Chapters 5 to 8 describe and summarise those case study findings according to the four RII portfolio domains. Each domain emphasises different RII model components. For example, the domain 'Regional orientation, strategic development and knowledge infrastructure' is mainly devoted to components 1, 2 and 6, while 'Education and human resources development' focuses on components 3 and

4 in the RII model. The various components are not always easily recognisable in the case studies.

The total set of 20 presents an interesting and illustrative cross-section of universities in Europe. It includes both broad 'comprehensive' ones, as well as those more 'specialised' in particular disciplinary areas (several are universities of technology). Several of the 20 are among the most high-profile research-active universities worldwide in terms of their international reputation and research performance. Many are one of the largest employers in their home towns. There are both medium and large-sized universities. The largest in terms of 'total graduates' (bachelor, master and doctoral students), the University of Bologna, is ten times larger than the University of Ruse. As for doctoral graduates, the Catholic University of Leuven is 20 times larger than Kaunas University of Technology in Lithuania and the University of Stavanger. The number of research publications in international scientific journals is a crude proxy of scientific research activities. The large research-active universities in Western Europe produce more publications than those in Eastern Europe, in order of magnitude; in the case of the University of Ruse, two orders of magnitude. These publication output counts are determined by many factors, apart from the ability to undertake international-level research. Nonetheless, the observed differences in terms of research capabilities are large and will affect their RII potential and RII pathways.

Given their interest to join our pilot study, our selection of universities is more than likely to represent those organisations that value or prioritise their regional engagement activities. As such, they are more likely to have developed successful RII strategies, capacities, and competences. If we consider these RII-active universities to be 'at the frontier' of these developments in Europe, it is imperative to consider their regional differences. As shown in Table 4.1, the innovation performance level of those regions, according to 2019 editions of Europe's Regional Innovation Scoreboard, varies from 'Leader' (four universities) to 'Modest' (one university). The other 15 universities are located in either a 'Strong' or 'Moderate' performing region. One cannot isolate a university's RII potential from its region's innovation performance. They are usually strongly connected, and probably interdependent.

The imposed constraints on the size of the self-appraisal reports (see Appendix A) prevented universities from providing full-scale, in-depth overviews of their RII profile. Nor was the information provided by the universities verified or validated by an external party. Given the limitations in their brief, it is not very surprising to see that their case study material tends to emphasise their achievements rather than presenting a critical review of their RII potential or performance, and provide no details on causal relationships within RII processes nor explanations for RII outcomes.

Featuring selected information from the case studies, Chapters 5 to 8 illustrate the breadth and depth of the information provided by the universities as well as the diverse nature of their RII portfolios and profiles. Some universities provided extensive and well-structured self-appraisal reports. Edited and shortened versions of five case studies are included in Appendixes B–F: Leuven University, Aalborg University, Technical University of Turin, Rovira i Virgili University, and Warsaw University. Two of these universities are from 'Strong' innovative regions and three from regions with a 'Moderate' performance.

Nonetheless, these self-appraisal reporting case studies present many interesting examples of the RII 'narrative with numbers' approach. They illustrate the many faces of RII, reveal a range of available in-house information within universities, and a variety of indicators they apply to substantiate their performance. The submitted empirical information also offers a glimpse of RII-relevant 'good practices' across European research-active universities. It also provides clues as to the feasibility of applying the RII analytical framework in practice, and the kind of RII-relevant facts that universities are able to supply, within a reasonable time-span, either for internal or external assessment.

4.2 SURVEY ON RII POTENTIAL AND ORGANISATIONAL CHALLENGES

Regional engagement is a necessary condition for any kind of RII potential and performance, though it may not be a sufficient condition to generate RII outcomes. To attain a better understanding of this engagement, our survey was designed to collect background information from the 20 universities on their RII performance profile. Driven by our RII analytical framework depicted in Figure 2.1 (section 2.1), our goal was to unearth information and impressions about their goals and motivation to engage in RII, the available in-house organisational resources, and whether or not they have implemented incentive systems to encourage regional engagement. We were also interested to learn in which particular RII portfolio domains they experience problems in regional engagement activities or obstacles to achieve their RII objectives. We were looking for new insights into their current RII-relevant processes and practices. Our aim was to detect general patterns that will help better understand critical factors in activating RII potential.

Ultimately, 12 universities returned our questionnaire: Aalborg University, Aalto University, Catholic University of Leuven, Kaunas University of Technology, Rovira i Virgili University, Technical University of Catalunya, Technical University of Turin, University of Aveiro, University of the Basque Country, University of Ruse, University of Stavanger, and University of

Warsaw. Collectively, they represent an interesting geographical cross-section of regionally active universities in northern, southern, eastern and western Europe. The survey findings are not representative for European research universities in general, but provide a general impression of what is happening in regionally engaged research-active universities.

In response to our first question, the large majority of those universities have adopted explicit strategies dedicated to 'regional orientation and engagement'; only two universities indicate that their regional priorities are implicit in the overall strategy, mission statements, or organisational structure. However, having a strategy does not imply a separate operational budget for 'regional orientation and engagement'; only four universities claim to have earmarked financial resources. Besides the fact that universities may not single out their region as a specific target, their funds for innovation-related activities tend to be distributed across functional lines or by various organisational units of the university. Nonetheless, some degree of centralisation does occur at lower levels. Seven universities indicate that they run a separate organisational unit, or employ dedicated staff, devoted to 'regional orientation and engagement'. The size of that facility differs significantly; in one case it is a unit with less than six staff members, three have six to ten staff members, and the other three units employ more than ten each. Several are a 'Technology Transfer Office' (TTO) or 'Technological Innovation Centre' type of organisation, others have broader missions and names such as 'Center for Career Development' or 'Centre for Cooperation and Dialogue' clearly indicating that these units have objectives beyond that of the more traditional TTO.

Evidence-based management and monitoring of regional engagement activities and achievements requires the gathering of factual information. Most universities indicate that this is indeed common practice in their case, either for the university's annual report, for organisational strategy development, or accountability reporting for the benefit of external (national) stakeholders. In nine cases that information package included performance metrics, especially with regards to 'funding', 'education' or 'research'. RII-related information on 'infrastructure' appears to be much less amenable to measurement; only four universities apply metrics and quantitative performance indicators in this area.

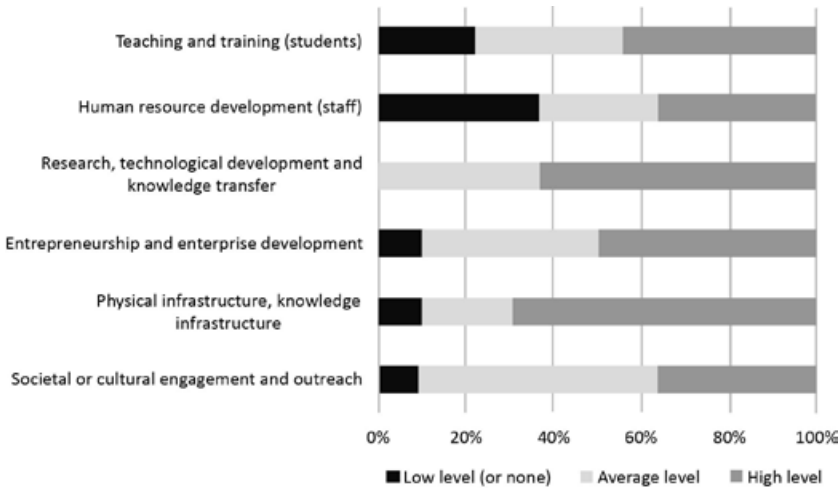
Moving from collecting background information on a university's regional engagement capacity to gauging the applicability of our analytical framework, it is important to ascertain if that framework can capture a diversity of RII-relevant organisational missions, and main attributes of their 'RII portfolio': a complex mix of RII-relevant resources, infrastructures, pathways, programmes and collaborative arrangements. Are universities sufficiently capable to identify, describe and self-assess such a portfolio? In our survey we again framed this question within the broader context of their regional engagement activities. We posed the question "how is your university's focus

on 'regional orientation and engagement' currently distributed (either in terms of invested resources, priority setting, or otherwise)?" We pre-selected the following categories to represent organisational missions: 'Teaching and training (students)', 'Human resource development (staff)'; 'Research, technological development and knowledge transfer', 'Entrepreneurship and enterprise development'; 'Physical infrastructure, knowledge infrastructure', 'Societal or cultural engagement and outreach'. These six categories correspond with our four RII portfolio domains.[6] We asked the universities to express that distribution in terms of general levels; either 'none', 'low', 'average' or 'high'. The findings illustrate that this categorisation and differentiation was comprehensible and meaningful. Seven out of 11 universities that responded to this particular question indicated that 'Research, technological development and knowledge transfer' was in the 'high' category; only four universities did the same for the category 'Human resource development (staff)'. The overall results, displayed in Figure 4.1, showing a distribution significantly skewed towards 'Research, technological development and knowledge transfer' and 'Physical infrastructure, knowledge infrastructure', with 'Human resource development (staff)' and 'Societal or cultural engagement and outreach' on the other side of the spectrum. These disparities not only indicate major differences within these universities in targeting or priority setting, but also possibilities for developing systems that may create more equity and impetus across the various organisational missions in terms of promoting, supporting or accelerating regional engagement.

Such incentive or reward systems are used at four universities, which answered affirmatively the question "Does the university apply a reward or incentive system – for students or staff – with regards to their 'regional orientation and engagement' activities and achievements?". These dedicated systems apply to any of the above mission areas. One university, for example, applies incentives for infrastructure, with discounts for renting the spaces, both office and laboratory space. Another university distributes scholarships and awards for students.

It is revealing to find that out of 11 universities that collect data on their regional engagement, only four are actively promoting it with incentives and rewards. This finding suggests the presence of organisational cultures, poli-

[6] The first two categories relate to the RII domain 'Education and human resources development', which is further discussed in Chapter 6. The third category relates to the RII domain 'Research, knowledge creation and technology transfer' (Chapter 7), while the fourth category aligns with the domain 'Support to enterprise development and entrepreneurship education' (Chapter 8). The last two categories relate to the domain 'Regional orientation, strategic development and knowledge infrastructure' (Chapter 5).



Note: One university answered 'none' for a domain, which was merged into the 'low' category to simplify comparability of scores across the domains.

Figure 4.1 Level of regional engagement activities within universities per domain (average score across universities)

cies, or other factors such as leadership commitments that prevent universities from applying such behaviour-influencing management tools. Touching on the issue of possible organisational obstacles, the survey's final question was "Are there specific area(s) in which your university faces major challenges with regard to developing or implementing 'regional orientation and engagement' initiatives or activities?" We specified seven domains, where such challenges may exist: 'Strategic priority setting at executive levels', 'Attracting or allocating dedicated funding', 'Attracting or allocating dedicated human resources', 'Creating general awareness among students or staff', 'Designing dedicated educational curricula or research programmes', 'Creating or upgrading infrastructures', and 'Engagement with local or regional partners'. We asked universities to respond to the question with a simple 'yes' or 'no'. Eleven universities responded and nine answered all questions. Figure 4.2 presents the aggregated findings. We found major differences as to where those challenges lie. Seven universities indicated that dedicated educational curricula or research programmes, focused on the local or regional environment, present them with problems. Dedicated funding also appears to be one of the headaches, as well as attracting or allocating human resources. Creating or upgrading infrastructures for regional engagement seems a relatively untroubled domain. Overall, we find that all these surveyed universities have developed

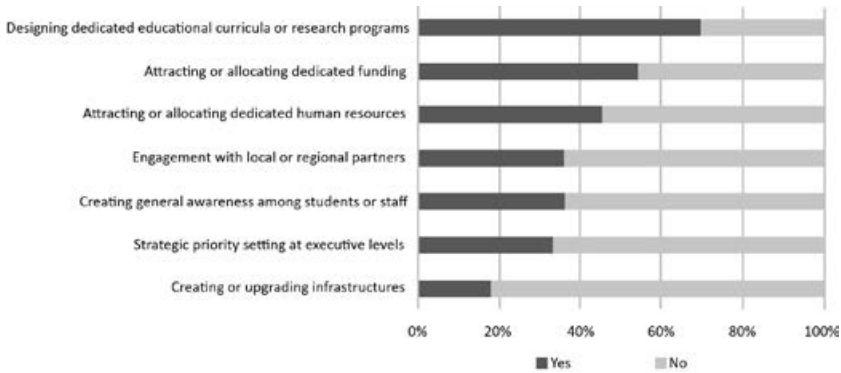


Figure 4.2 *Existence of major challenges with regards to 'developing or implementing regional orientation and engagement initiatives or activities' (average score across universities)*

organisational structures and facilities to reach out and interact with partners in their 'local' and 'regional' environment. All in all, the findings from this survey present interesting background information on their ability to undertake successful regional engagement, but also highlight important organisational issues concerning their current capacity to develop RII activities.

An interesting finding from this survey is the relatively low number of universities that have adopted dedicated incentive or reward systems to improve their regional orientation and engagement. Given the strong regional orientation of most universities one would expect to see more encouragement mechanisms in place for students and staff. Major challenges in specific areas, such as developing dedicated educational curricula or research programmes, suggest a need for further initiatives or policies to address such problems and obstacles. Implementing targeted incentives may be part of the solution or establishing more effective mechanisms to interact with municipal or regional stakeholders and leaders in order to calibrate regional engagement structures and practices. We return to the topic of incentives and funding instruments in Chapters 9 to 11.

Each question invited additional commentary for supplementary information from universities. The survey's final 'open' question provided space for further general remarks. This feedback helped us to assess the general validity of our RII analytical model (depicted in Figure 2.1, section 2.1). This model assumes that a university's regional engagement 'goals' are largely determined by socio-economic or environmental 'needs, problems, issues' explicitly associated with the local or regional area. However, only a few universities

acknowledge such strong ties with local or regional stakeholders, and a possible 'enforced' regional orientation.

In many other cases the involvement of those stakeholders tends to be implicit in so far as it is incorporated into the overall goal or broader 'ecosystem' strategies focusing on outreach and cooperation with society and industry in general. In one case, regional engagement is seen as part of the larger 'third mission' dedicated to creating public value via processes of open engagement. Another university has no specific central strategy on regional engagement, but has integrated it into educational and research activities of its individual staff members. Moreover, several universities indicate that goals are set at a broader level – with no specific reference to the local dimension – but several of them may nonetheless have a significant impact on the immediate geographical environment. Such 'global' universities do not restrict societal and economic impact strategies to the local region, but aim to create and maintain ecosystems that contribute to industrial and societal renewal irrespective of proximity – either locally, regionally, nationally or even globally.

Clearly our analytical model, which focuses exclusively on the immediate environment, falls short in terms of incorporating such broader spatial spill-over effects. The extended RII model in Figure 3.1 (section 3.1) provides an impression of how the local and regional is intertwined with the (inter) national environment.

4.3 SELF-REPORTED RII INDICATORS

The prescribed 'narrative with numbers' format offered the universities a wide range of possibilities for presenting their RII profile and describing their RII portfolio within the required general template (see Appendix A). We expected to find a lot of descriptive text, perhaps some data tables and graphs, but hopefully also some RII-specific statistical data. Both the 'narrative' and the 'numbers' parts of their self-appraisal report could contain references to specific empirical information on identifiable components of their 'RII potential' or 'RII performance' as shown in Box 4.1. Such information elements could be used, within an RII analysis framework, as a proxy measure (an 'indicator') to succinctly describe an RII profile. While a metrics-based 'quantitative indicator' would represent the volume or size of an element in a specific component, for example the number of students with internships in local firms, a non-metric 'qualitative' indicator would, for instance, refer to the occurrence (or absence) of a particular RII pathway within a university.

BOX 4.2 GENERAL CATEGORIES OF RII-RELATED INDICATORS

Quantitative indicator – 'foreground' metrics-based information of RII potential or RII performance (e.g. percentage funding from local sources, number of TTO-generated results related to local SMEs, etc.); explicit reference to either the 'local' or 'regional' dimension of a university's portfolio or mission; includes specific numerical or statistical data;

Qualitative indicator – 'foreground' occurrence information on RII potential or RII performance (e.g. active participation in smart specialisation strategies; region-related targets in a strategic plan of a TTO, etc.); explicit reference to either the 'local' or 'regional' dimension of a university's portfolio or mission;

Other 'foreground' indicator – an integrated mix of quantitative data and qualitative information (or indicators with insufficient information to accurately determine their exact nature); explicit reference to either the 'local' or 'regional' dimension of a university's portfolio or mission;

'Background' indicator – no explicit reference to either the 'local' or 'regional' dimension of a university's portfolio or mission; directly or indirectly related to RII potential, RII performance or performance-enhancing support conditions (e.g. presence of RII relevant physical infrastructure in the area, relevant framework conditions such as impact-promoting university leadership, implementation of performance-based incentive systems, presence of a TTO or business accelerator facility or student entrepreneurship facilities, etc.).

Given the current lack of RII-specific quantitative indicators in general, one would expect to find a large share of qualitative indicators in their self-appraisal reporting, particularly in those components of their RII profile that are weakly developed in terms of in-house management information systems or measurability. To test this hypothesis we classified the references to such indicators into four categories: three types of 'foreground' indicators that specifically refer to the university's geographical area, and 'background' indicators with RII-relevant information of a more general nature (see Box 4.2 for more details). In our content analysis of the 20 university reports we identified 408 references in total, an average of 20 per case study.[7] The summary statistics of the content analysis are presented in Table 4.2. The spread of references across

[7] The exact number of references is difficult to determine for various reasons, but mainly because essential details are lacking in the text or the presence of ambiguous cases that could be allocated to more than one indicator category.

Table 4.2 Distribution of RII indicator categories (20 case study self-appraisal reports)

Indicator category RII portfolio domain	References (count)	Quantitative indicators (% of row total)	Qualitative indicators (% of row total)	Other foreground indicators (% of row total)	Background indicators (% of row total)
Regional orientation, strategic development and knowledge infrastructure	**146**	8%	47%	13%	32%
Education and human resources development	**105**	13%	17%	9%	61%
Research, knowledge creation and technology transfer	**77**	9%	25%	4%	62%
Support to enterprise development and entrepreneurship education	**75**	7%	25%	0%	68%
Total	**403**	9%	31%	8%	52%

the four categories shows a dominance of 'background' indicators (52% of all references) and qualitative 'foreground' indicators (31%), while only 17% can be described as quantitative. Clearly, the 'narratives' dominate the 'numbers' in these self-appraisal reports.

Qualitative indicators are referred to relatively often when universities describe their activities in the 'Regional orientation, strategic development and knowledge infrastructure' domain of the RII profile; almost half (47%) were qualitative indicators that implied a specific geographical impact. The most common qualitative indicators, occurring more than ten times, were 'cooperation with local/regional authorities', 'participation in regional clusters' or incubators and organisational changes to increase RII (such as 'changes to research portfolios, curricula or human resource policies'). Just 32% of the indicators were background indicators, far less than in the other three domains where the regional dimension is less explicit. Frequently occurring is the 'commitment of the university to strategic regional partnerships', often formalised in a mission statement, as well as a 'commitment to solve regional skills shortages'. Finally, several quantitative indicators are also identified, such as the 'value of grants from regional organisations' and '% of (regional) external board members in the university governing bodies'. Several indicators related to origin and des-

tination of students were included in this section of the self-appraisal reports, despite it being an issue more relevant for the 'Education and human resources development' section. Content analysis of that section identifies more than 100 references across 25 indicators. Compared with the regional dimension, there was a greater proportion of background indicators (61%). Some of the most common were on building entrepreneurial mind-sets among students, problem-based learning and recruitment rates (i.e. the percentage of students finding a job within 12 months). As for quantitative indicators (representing a 13% share of all indicators in this domain), most were related to the origin of students and lifelong learning; others were the 'number of internships' or 'percentage of students following work based courses'.

With regard to the 'Research, technological development and knowledge transfer' sections in the self-appraisal reports, almost two-thirds of the 77 observed cases are 'background' indicators. The vast majority relate to RII potential. Several indicators belong to facilities, infrastructures, and activities within component 3 in Box 4.1: 'Resources, general facilities and/or incentive systems within the university'. Given the low numbers of references we decided to group several of those indicators into an aggregate-level 'composite' indicator that represents a 'structural' feature of the university's RII profile. The most prominent of those composite indicators, with 15 references, can be described as 'Dedicated facilities and infrastructures within the university for transfer and commercialisation'. This includes the existence of entrepreneurship centres, technology transfer offices, business incubators, and business accelerators. Three other composite indicators with more than five references are: 'Engagement or cooperation with industry and/or public sector networks' which may involve dedicated organisational consortia but also joint meeting platforms; 'Dedicated facilities and infrastructures within the university for internal processes' covering support offices, clubs and social platforms, and committees; 'General facilities and infrastructures outside the university', comprising science parks, shared laboratory space, co-working and co-creation spaces, and meeting platforms. Three of those composite indicators also appear in the list of 'qualitative' indicators, where the connections to local or regional users or partners are now quite explicit: 'Engagement or cooperation with industry and/or public sector partner networks'; 'Dedicated facilities and infrastructures within the university for transfer and commercialisation'; 'General facilities and infrastructures outside the university'. Three 'quantitative' indicators are mentioned more than once: 'Size of business sector oriented spaces (co-working and co-creation spaces, lab space, office space)'; 'Amount or share of funding from external local or regional sources'; and 'Number of research contracts, projects, post-doc positions, and/or partners in a local or regional partner'.

As for the next section in the reports, on the RII domain 'Support to enterprise development and entrepreneurship education', here we identified 75 references, with a 68% share of 'background indicators'. There is a large similarity with the list of indicators mentioned in the 'Research, knowledge creation and technology transfer' domain, which is not surprising in view of the close organisational connections between both domains. By far the most frequently composite indicator referred to is, again, 'Dedicated facilities and infrastructures within university for transfer and commercialisation' with 20 references, many of which relate to entrepreneurship centres and dedicated education. The runner-up is the qualitative indicator 'Engagement or cooperation with industry and/or public sector partner networks in the region' (seven references), while the background indicator 'Dedicated facilities and infrastructures within university for internal processes' is mentioned five times. The latter indicator covers specialised support offices, specific clubs and social platforms, or special events such as student entrepreneurship competitions. Only three quantitative indicators are mentioned in all case study reports, each indicator only once. One of those three would almost certainly qualify as a high-profile 'key performance indicator' for any RII aspiring university: 'Number of jobs and amount of revenues created by spin-offs supported by the university's region-oriented business incubator'. Surprisingly, only one out of the 20 universities mentions this indicator explicitly. Section 9.1 discusses possible reasons for including or excluding particular indicators.

5. Regional orientation, strategic development and knowledge infrastructure

5.1 IMPORTANCE OF REGIONAL ENGAGEMENT FOR INNOVATION

Research active universities are potentially crucial actors in 'knowledge-based' regional innovation systems, but some have a much greater impact than others. This is shaped by two sets of factors: on the one hand, the managerial, regulatory, and infrastructural frameworks in which universities interact with their local environment defines the RII potential and chances of success. On the other hand, strategic partnerships with regional authorities and other actors in the innovation system allows this potential to be realised. While some universities may take a leading role, even helping to orchestrate the whole innovation system (e.g. Rissola et al., 2017), their regional impact also relies on the performance of other actors and the collective implementation of a common strategy.

Within universities, strong leadership and an encouraging environment supportive of entrepreneurial and innovative processes is essential for their RII performance (Sánchez-Barrioluengo and Benneworth, 2019). Leadership must be responsive for an organisation to be dynamic and successful. Flexibility, adaptability, and adequate resources are indispensable for successfully navigating such dynamic environments; to survive and thrive during unpredictable and complex times (Johannessen and Skaalsvik, 2014). University leadership and governance can incentivise locally oriented entrepreneurial and outreach behaviour, driven by a university-wide shared vision and culture that incorporates RII prioritisation.

University leaders who have dealt primarily with their internal organisational environment are increasingly required to manage relationships with a wide range of private and public sector stakeholders. More than in the past, they must be able to demonstrate the value they add to society in order to qualify for their share of increasingly scarce public resources. In doing so, they need to give the entire organisation a common purpose, challenging all their

staff to ask themselves not just what they are good *at*, but what they are good *for* (Goddard et al., 2016). This is increasingly framed not only in terms of economic growth but also in terms of a wider contribution that helps achieve the United Nations Sustainable Development Goals (Nhamo and Mjimba, 2020). In 2019 the Times Higher Education Impact Rankings including metrics related to the SDGs for the first time.

University leadership needs to create appealing RII stories and an accompanying culture of regional innovation. Although RII, in one way or another, may be mentioned in a university's vision statements or strategic plans, the ambitions with regards to a university's societal stewardship, custodians of regional heritage or culture, or other engagements with local communities are often not explicitly defined or described. The regional orientation, in terms of generating RIIs, should not ignore or underscore the relevance of social innovations and a large variety of societal impacts. Examples include citizenship, policy debate, environmental awareness, cultural enlightenment, and general well-being of the population. Although not directly or necessarily of immediate economic significance, these impacts may have huge longer-term positive effects on the effectiveness and sustainability of regional innovation systems. Even more importantly, these impacts are a defining characteristic and integral product of many universities, which runs through all dimensions of their societal mission.

Senior university managers are now expected to cooperate with local and regional policymakers, to help them deal with complex policy and practical challenges on issues such as strategic development or supportive knowledge infrastructure. The development of regional partnerships with governmental and private sector actors can help to align university and regional strategies to better match supply and demand for knowledge and skills, especially in the context of 'Smart Specialisation' (Edwards et al., 2020), a policy concept that has gained momentum among the European Union's regions (see Box 5.1).

BOX 5.1 SMART SPECIALISATION STRATEGY

In 2010 the European Commission called on national and regional governments to develop a 'Smart Specialisation' strategy for research and innovation to encourage all European regions to discover and develop their competitive advantage (European Commission, 2010). The approach was operationalised principally through the European Regional Development Fund, which requires Member States to have a smart specialisation strategy at national and/or regional level in order to make R&I investments. Smart specialisation policies are designed to empower those institutional actors that are capable of realising potentials with the aim of generating distinctive

competitive advantages in a regional economy (Foray and Goenaga, 2013; Goddard et al., 2013).

The resulting policy processes are meant to select and prioritise those areas where a cluster of activities could develop, usually those which are already strong or show promise for a region and which can benefit from (more) R&D and innovation. Smart specialisation policies advocate regional partnerships to foster 'entrepreneurial discovery processes' (Foray, 2014). Effective regional smart specialisation requires effective partnerships, sustained coherent objectives and policies, and open and inclusive systems with the participation of all regional stakeholders. When properly aligned, regional innovation policies may reinforce each other at the regional level (Fitjar et al., 2019).

Regional governments are also becoming increasingly aware of the importance of building stronger partnerships with universities, particularly in terms of the skills and human capital integration within innovation policies (Edwards et al., 2020). Europe's smart specialisation agenda has challenged Member States to introduce new forms of governance that facilitate collaborative leadership. In this new context, universities in Europe are facing important challenges, mainly associated with demands to become more entrepreneurial, with stronger leadership to shape innovation policy in cooperation with other local and regional R&I actors.

One of the features of smart specialisation is that regions are challenged to create a shared vision among the different R&I actors. Universities can play the role of a 'neutral knowledge broker', reconciling different interests and perspectives, helping to lead regional participatory processes (European Commission, 2020). This can be particularly important in regions with low levels of trust and without a culture of cooperation and civic engagement. Similarly, the smart specialisation approach relies on a process of entrepreneurial discovery where bottom-up search processes provide the information required for policymakers to set innovation priorities. Universities can help bring together the entrepreneurial and innovation communities to explore the strengths of a region, while operating as an intermediary with the regional government. Such a role for universities is even more important in less developed regions with low levels of 'institutional thickness' (Vallance et al., 2018; Zukauskaite et al., 2017).

Applying our analytical model and the RII analytical framework, as displayed in Figure 2.1 (section 2.1), this chapter touches on two categories in that framework: the 'Needs, problems and issues' with the local or regional environment and its relationship to 'Goals and motivation' on the university side. Focusing our attention on the university perspective, sections 5.2 and

5.3 present an illustrative overview of how various universities engage with local, regional, and national authorities to (co-)develop and implement their RII-related objectives, strategies and programmes. Section 5.4 explores the interactions between the international and regional levels, adding another level to the analytical framework that is displayed in Figure 3.1 (section 3.1) and how research-intensive universities are uniquely positioned to harness global knowledge for the benefit of the place in which they are located. The final 'Conclusion' section summarises the main findings and draws some general conclusions.

5.2 RII DELIVERY SPACE: COLLABORATION IN REGIONAL SPECIALISATION STRATEGIES

Universities are in the position to help create institutional environments where education, science, business, and government meet and interact. By broadening and strengthening local or regional collaborations and connections, universities are better positioned to address socio-economic challenges. Such partnerships are also seen as desirable to shape a region's innovation strategy. Challenges and obstacles to regional innovation systems which universities can help to overcome include brain drain, low levels of lifelong learning and entrepreneurial skills, and few intermediaries to facilitate cooperation. The role and position of the university can determine the shape and nature of the entire regional innovation system, especially if those universities become innovation system integrators (Rissola et al., 2017). Most universities in our sample maintain active relationships with the local and regional authorities as well as other stakeholders in the region. Many universities are an institutional partner in strategic agreements for regional development, or a participant in regional coordination bodies. The RII self-appraisal reports include a variety of organisational arrangements, which not only illustrates the wide range of possibilities but also how much the interplay between universities and their local governing bodies may depend on local circumstances and opportunities.

Two out of three of the young innovative[1] universities in our sample; Aalto University, Aalborg University and the University of Stavanger were established relatively recently with the clear mission to help bring about either the building or rebuilding of their regional innovation ecosystems creating new business opportunities for their collaborating partners or attracting new industrial development to the region. Their strong dynamic management actively

[1] Self-declared 'innovative universities' as members of European Consortium of Innovative Universities (ECIU).

engages with regional governmental actors and other stakeholders in their regional ecosystem to contribute to the definition of a shared vision.

A recent case study of Aalto University (Rissola et al., 2017) analysed the way it helps orchestrate its regional innovation system, by interacting with regional actors while generating new business opportunities and new businesses, for example by bringing researchers from university and industry together on its campus around strategic new areas of development. Norway's University of Stavanger, another entrepreneurial university, actively supports three regional cluster initiatives within the Norwegian government's ARENA programme designed to support immature, but high-potential clusters. In collaboration with the Stavanger municipality the university also participates in the EU Smart Cities and Communities Lighthouse project 'Triangulum' for transforming Stavanger into a smart city/region. Another initiative is the Strategic Business Plan developed by Greater Stavanger Economic Development. The priority areas for development outlined in this plan tie into the current strengths and future development priorities of the university. Aalborg University (see Appendix C) was established with the explicit aim of raising the innovative and economic potential of North Denmark, a less developed region in the Danish context. It has a long-standing cooperation with the local authority and regional growth centre to promote strategic cooperation in common regional innovation challenges.

Turning to some examples of technical universities in our sample one observes they seek to align with their region's specialisation objectives – and often help shape them. The University of Strathclyde's Principal is Chair of the Glasgow Economic Leadership Board, which brings together business and civic leaders and has played a key role in developing the Glasgow City economic strategy. This Board includes leaders of the ten key economic sectors in the city today; students and researchers of the university engage strongly in five of these sectors. The University of Strathclyde is also an anchor organisation in the development of the National Manufacturing Institute for Scotland (NMIS) as part of Glasgow's Manufacturing Innovation District. The NMIS is a strategic collaboration between the Scottish Government and the university to enhance the competitiveness of Scottish industry through adoption of cutting-edge research and innovation, and improving skills provision.

The regional government of Turin developed a new strategic plan, to define priorities, in terms of regional technological specialisations giving the university system a key role. In line with the regional strategic plan, the Technical University of Turin (see Appendix D) implemented programmes aimed at supporting the ongoing transformation towards a more diversified economic system, integrating Information and Communication Technologies (ICT) to the traditional manufacturing competences of the region, while favouring the creation of new industries. It created 11 new inter-departmental research

centres focusing on the key enabling technologies with the objective to tackle the current regional needs of nurturing and diversifying the economic system towards emerging technologies. The Technical University of Catalunya is one of the most active participants in the RIS3CAT communities, a programme put in place by the Catalan government to ensure the continuous engagement of stakeholders in the selected smart specialisation priority areas. The university aligns its efforts to create ecosystems that foster research, innovation, and entrepreneurship with the RIS3CAT communities' organisational structures.

Considering smaller universities with a regional focus, the University of Ruse strongly intensified its work with business and regional authorities through a number of initiatives: Employers Days, developing an Information Portal for Business Partners, and joint projects with business under the Operational programmes of the Bulgarian government. The university plays an important role in the configuring of the regional systems and policies. Many of the key figures in regional public institutions are alumni of the University of Ruse. Furthermore, representatives of the university participate in all specialised committees, established at local and regional level, and make a significant contribution to solving local and regional problems in Bulgaria and the Bulgarian–Romanian cross-border region. Rovira i Virgili University in Catalunya (see Appendix F for details) has built up a network of six public research centres, four technology centres and various business associations, all of which have close connections to the regional priorities. This network facilitates the interaction between the university, the research and technological centres, and the manufacturing sector.

The large comprehensive universities in our sample also actively interact with their regional governments in the development of regional or municipal development strategies. Academics at the University of Warsaw were involved in creating the city's 'Development Strategy 2030', the main strategic document for local authorities. Together with municipal officials these experts in regional development, geography, economics, and sociology co-created a broad-scale inclusive process leading to recommendations for the city's future development (see Appendix E for more information on the University of Warsaw). Leiden University in the Netherlands is now co-located in two neighbouring municipalities: Leiden and The Hague. The university aims to reinforce its presence in The Hague by participating in The Hague Security Delta, and strengthening its collaboration with the University of the Arts. Moreover, Leiden University is a partner in national and international administrative, political and legal institutions in The Hague to further enhance The Hague's specialisation profile: a city of international law, peace and security, a centre of Dutch public administration, and increasingly as the city of international governance. Leiden University, Delft University of Technology, and Erasmus University Rotterdam, have created a strategic alliance in the South

Holland region of the Netherlands with inter-university centres and joint science and scientific-medical programmes. Italy's University of Bologna played a key role in the creation and development of the Emilia-Romagna High Technology Network. Focusing on the specific characteristics of the regional ecosystem, the university directly participates in several regional coordination bodies. The university is one of the founders and shareholders of the Regional Coordination Agency for Technological Innovation, ASTER, which steers all the activities of the ER High Tech Network, and acts as the Scientific Advisor for the Strategic Plan of the large Bologna Metropolitan Area. The Catholic University of Leuven (see Appendix B) regularly consults with its local stakeholders, such as the Leuven-based Interuniversity Microelectronics Center (Imec) and the city council members of its hometown. Since 2016 these interactions have been further consolidated leading to the establishment of the 'Leuven Mindgate' initiative to enhance the city's regional branding. The university has built strong ties with several other cities in the Belgium province of Flanders, allowing the university to extend its network of science parks and incubators. There are also very intense collaborations with the province of Flemish Brabant in order to promote the entire region as a knowledge hub to attract foreign companies, via an initiative called 'Flanders Smart Hub'. At the Flemish government level, the university collaborates with agencies like Flanders Innovation & Entrepreneurship, Science Foundation Flanders, the Department of Economy, Science and Innovation of the Flemish Government, and Flanders Investment and Trade.

BOX 5.2 UNIVERSITIES AND MONITORING OF SMART SPECIALISATION STRATEGIES

Innovation strategies help to create 'learning regions' (Morgan, 1997), whereby a territorial knowledge base is co-created among innovation actors and codified by regional authorities. However, this is no easy task and public authorities often lack the technical skills and capabilities to collect and analyse such data. They would be wise to look at regions where public authorities and universities have worked together in this task. Furthermore, monitoring is an essential part of smart specialisation strategies (Gianelle et al., 2016), which makes it more important for all regions to develop this territorial knowledge base. An example of such cooperation is the Northern Netherlands Innovation Monitor, which was set up in the University of Groningen by the Northern Netherlands Alliance, the regional body responsible for smart specialisation. It includes an annual survey of SMEs to understand their characteristics, behaviour and potential discovery of new innovation opportunities. Following the principle of reciprocity, the mon-

itor provides each participating SME with a benchmark report, as well as the chance to join an expert panel or policy review workshop, allowing local firms to influence the development of smart specialisation priorities. Another example is from the University of Vaasa in Finland, which, in co-operation with the Regional Council of Ostrobothnia, has designed a tool called the Connectivity Model to measure the connections and interactions between local actors. Based on a survey, focus groups and gap analysis the tool has helped Ostrobothnia to better understand its regional innovation system and which areas of innovation to prioritise in its smart specialisation strategy.

While there is clear potential, few of the case studies show how the universities' social sciences research capacities contribute to generating knowledge on the regional innovation system and smart specialisation. There are some examples, such as the development of a sub-regional innovation scoreboard at Rovira i Virgili University, the contribution of social scientists of the University of Warsaw to its city's development strategy, or the partnership between The Hague municipality and Leiden University to explore the possibilities of incorporating urban issues in the research carried out by the university research teams. However, we can find inspiration from other universities, such as those involved in the JRC project on Higher Education for Smart Specialisation. Box 5.2 shows how universities have been key partners for regions in monitoring their smart specialisation strategies.

5.3 RII DELIVERY SPACE: INTER-REGIONAL AND INTERNATIONAL COOPERATION

Research-active universities usually have significant international networks through joint projects and publications, which are necessary to remain at the forefront of an academic field and to access funding. Internationalisation has also increased within higher education, with growing levels of mobility among students and staff (the Erasmus programme has accelerated this trend within Europe). On the one hand this is a challenge to the university's RII because academics are called upon to educate 'citizens of the world' which are less likely to enter the local labour market. Research is targeted towards peers and when policy relevant usually national or supranational authorities rather than the regional level. These factors are built into the career incentives of individual academics as well as objectives for departments and faculties. However, the case studies also show that universities can act as a link between the global and local levels, absorbing international knowledge and sharing this with other

regional stakeholders. Institutional funding needs to recognise and value this role more.

A first example of how universities can help internationalise the regional ecosystem is provided by Aalto University. At the time of its establishment in 2010, substantial effort was given to increasing the new university's international position and in a short period of time it has expanded its global reach. For example, the UN Technology Innovation Lab network is located on the campus, as is a business innovation incubator of the European Space Agency. This international profile helps to attract talent and business, improving the whole regional innovation system. Kaunas University of Technology provides an example of the importance of international ties in the Baltics. Its local region spans several countries. The university's national innovation and entrepreneurship centre through its business incubator start-up space leads inter-regional projects for entrepreneurship promotion. These projects are focused on strengthening links between Lithuanian, Polish and Latvian neighbouring districts. In February 2012, the Kaunas University of Technology and Aalto University's Centre for Entrepreneurship signed a memorandum, which was the basis for establishment of the university's Innovations and Entrepreneurship Centre.

Smaller regionally oriented universities tend to have more limited possibilities to engage internationally, except through the opportunities provided by the EU Framework Programmes. However, some can benefit from their specific geographical location. For example, the University of Ruse has built a reputation as a knowledge hub within the Danube macro region. It has participated in key projects of the European strategy for the Danube as well as many cross-border projects with Romanian partners, funded by the InterReg programme. This in turn has helped North Central Bulgaria and the city of Ruse develop local and regional innovation strategies, although the impact is limited by a national approach to smart specialisation.

Larger comprehensive universities often play at the European or even global scientific stage. They can help embed their local region in international networks. Leuven University has partnered with other regional actors in European initiatives, notably the EIT Knowledge and Innovation Communities, in which the university acts as an innovation hub for two (Raw materials and Food) and is an active partner in two more (Health and Energy). An example at the project level is EnergyVille, funded both by EIT Innoenergy and the ESIF. Leuven University is actively involved in cross-border collaborations, such as ELA-T, a network linking Leuven region to universities in Eindhoven (Netherlands) and Aachen (Germany). Appendix B provides more detail on the Catholic University of Leuven. The University of Bologna has developed a structured long-term approach at the regional level in aligning local policies with the EU Framework programmes. This strong link with a supra-national

programming context has made it easier to reconcile the short-term quest of an advanced industrial system mainly based on SMEs, with the participation in long-term innovation challenges.

5.4 CONCLUSION

This chapter argued that universities can make a major contribution to regional development strategies, acting as 'anchor organisations' that promote knowledge as a driver of economic development. Some universities even take an orchestrating role in conjunction with other actors in their regional innovation system. Dynamic management is a central factor in this, although it is also shaped by the regulatory environment and other structural factors outside the university's control.

Turning to our RII analytical framework in Part I, the chapter illustrated how universities engage with regional governance structures and align their activities with specific regional priorities. Assessing a university's performance in these RII delivery spaces also requires an assessment of how its internal resources and incentives react to those of the regional innovation system as a whole and the way this feeds into it through its goals and motivation.

The multi-level nature of innovation impact is shown through the examples of universities cooperating with international partners, not just in terms of research but through links with other actors in the different regional innovation systems. Such interactions are increasingly supported by EU funding such as through the EIT Knowledge and Innovation Communities, a component of its R&I framework programmes that aims to build systems rather than just fund individual projects. These systems bring together the education, research, and enterprise development activities of universities, which are addressed more closely through examples in the following chapters.

6. Education and human resources development

6.1 IMPORTANCE OF TEACHING AND TRAINING FOR INNOVATION

The contribution of universities to human resource development in their home regions can take many forms: disciplinary formation, targeted skills training, or attracting talent to the region. Many university graduates moving into society and the business sector are 'innovators' in one way or another; they bring their newly acquired knowledge and skills, their novel methods and new ideas into practice.

New expectations and complex requirements require universities to adjust their educational approaches to better develop the skills and competences needed in future labour markets. Furthermore, they have to manage demographic changes which includes a declining number of young people and a growing demand from mature students. Responding to these needs and pressures, universities have adopted different approaches to ensure a better fit between supply and demand of skills in their local geographical area and enhance the employability of graduates in the labour market. They have adapted their curricula towards teaching skills, rather than mastering a single profession, and to engage more in the provision of lifelong learning and more personalised programmes. Teaching methodologies are also changing to become student centric and problem based, with a greater proportion being delivered online through distance learning.

University graduates bring fresh, research-infused knowledge and skills to their regional private and public sector employers. Research universities are also putting increasing effort into providing their graduates with the skill set to interact with people trained in different disciplines. Many societal, environmental, or economic problems occur at the overlap of complex natural and socio-technical systems that can only be addressed successfully by collaborative cross-disciplinary teams. Through their disciplinary formation these graduates also need to have a good perspective on who they are, and how they might contribute positively to the heterogeneity they will encounter in local, regional and global communities (Hill et al., 2016).

It is a well-known fact that international students bring economic benefits to their home regions (Vickers and Bekhradnia, 2007). An important role of many research universities is to facilitate links to a wide range of partners and embed their regional presence in national or global networks. Adopting an international perspective will remain important in the future – also in the post-pandemic period. Students will want to develop global competences in languages and intercultural skills. Universities may meanwhile want to continue attracting talented foreign students and recruit foreign staff to their organisation. Some of these graduates may settle permanently in their local city: a strategy to keep skilled young talent in the region.

Sections 6.2 to 6.3 further describe how initiatives, activities and facilities within these universities help to shape the RII potential and drive their RII performance in areas of teaching and training for human resources development. Applying the analytical model from our RII analytical framework (Figure 2.1; section 2.1), these sections relate to two of the model's main categories: 'RII resources' and 'RII delivery space' respectively. The 'Conclusion' section summarises the main findings and draws some general lessons.

6.2 RII RESOURCES: INNOVATIVE TEACHING APPROACHES

The universities that contributed to the RII case studies have developed and employed innovative teaching methods, including through the active involvement of regional firms in curriculum design and delivery. This may involve private sector participation in teaching by way of guest lectures, real-life case studies as well as through internships, summer jobs and master thesis opportunities. The case studies illustrate a trend towards increasing competences among students, such as entrepreneurship or team work, in order to produce rounded and flexible graduates, who are increasingly demanded by employers. For instance, the University of Aveiro in Portugal runs the 'Learning to Be Programme' based on the 'Activation of Entrepreneurial Thinking' (ACTE) methodology. The aim of the programme is to foster the development of students' competences that meet current and future innovation demands. In this learning process, students are stimulated to address challenges from different perspectives and design disruptive and creative solutions for them.

Such competences can also be built using real world examples or problems that are encountered by local firms and governments. Many of the universities in our sample, in particular Aalborg University, Aalto University and the Catholic University of Leuven document initiatives to promote 'problem-based learning' and/or 'project-based learning' (PBL), which is explained in Box 6.1.

BOX 6.1 PROBLEM-BASED LEARNING

An innovative teaching method that is used by a number of the universities in our sample, 'problem-based learning' (PBL) is based on the creation of loosely defined, realistic and open-ended problems which students attempt to solve through team work. PBL is based on learning which occurs through one or more activities leading to the achievement of a final 'real' innovative product or service: a design, device, service, software, or computer simulation. Many types of skills can be acquired or mobilised and practised in this form of learning. Working for common goals in a team for a longer period involves the need for both managing conflict and dealing with different working and thinking styles, as well as continuously adapting to a changing environment. With well-designed and appropriately framed problems, PBL can contribute to the intellectual and skill development of students (Adams Becker et al., 2017). Problem-based approaches together with interdisciplinary learning are also believed to facilitate meta-cognitive skill development, by emphasising the importance of critical thinking, flexibility, innovativeness and soft skills (OECD/EU, 2018).The PBL model teaches students how to acquire knowledge and skills independently. Being exposed to such a learning environment, students are better prepared for the labour market, as they have learned to work both independently or with other professionals on real cases, interacting with firms and public sector organisations. Dealing with practical problems in their courses and research projects ensures a degree of fit with the needs of local (and international) employers.

At the Aalborg Center for Problem Based Learning in Engineering Science and Sustainability, students work on real cases interacting with local or international companies and local or national public organisations throughout their education. All degree programmes and research activities at Aalborg University involve problem-based learning and also have a clear interdisciplinary focus in close interaction with public organisations and private sector firms (for more information see Appendix C). Similarly, the Product Development Project (PDP) at Aalto University's Design Factory offers interdisciplinary teams of students, during a full academic year, a problem-based learning approach in which they solve problems given by companies; the results are publicised during a demonstration day.

The Product Innovation Project at the Catholic University of Leuven is perhaps the most locally rooted of all the PBL examples in our case studies. Designed by students themselves, the course addresses problems that originate within The Leuven Community for Innovation Driven Entrepreneurship

(LCIE). This is the university's centre for entrepreneurship education that was set up and is funded by both the local government and the private sector. With strong local stakeholders, students are introduced to real life problems in the community. At the end of the course the students are required to deliver a working prototype of a product together with an extensive value proposition and a brief business plan.

6.3 RII DELIVERY SPACE: ATTRACTING TALENT

When Aalto University was founded in 2010 only 8.1% of its students were of foreign nationality, whereas in 2017 this proportion had increased to 14.6%; in 2017 at University of Warsaw the number of foreign PhD candidates accounted for 9% of the total, while the percentage of international students at the University of Warsaw has grown 2.5 times over the past ten years. The efforts made in recent years by the University of Bologna in the internationalisation of its educational offer resulted in over 50% of its students coming from abroad, which is one of the highest shares of foreign students in the country.

In general, most students tend to benefit from internationalisation, because contacts with foreign students allow them not only to establish powerful networks but also to understand other cultures. Both experiences prepare them for working in a global environment. From the regional perspective, the most important positive side effect of internationalisation is the potential of retaining large numbers of international students.

It remains a challenge to retain international students after their graduation but in countries where the institutional framework allows, the clear advantage of retaining them in regions where they were educated is that they can join the labour market immediately without additional training or the need for a screening of their competencies. Some of the international students attracted by local innovation opportunities may also remain to start a business. In some national contexts the conditions for retaining skilled foreign students are easier. For example, in the Netherlands, foreign knowledge workers, including foreign post-docs can benefit from favourable tax treatment. The absorptive capacity of a region, including the presence of high-tech firms with a clear demand for high skilled labour, is a crucial factor in retaining students.

6.4 RII DELIVERY SPACE: EMPLOYABILITY AND EMPLOYMENT OF STUDENTS

Some of the case study universities involve firms in the design of specific study programmes in order to make the educational offer a better match to regional needs. The University of Trieste performs regular consultations by the coordinators of graduate programmes to discuss the effectiveness of their

curricula with an eye on designing courses that cater for the skill needs of particular business sectors in which the local economy is specialised**.** Also, most faculties of the University of Warsaw involved regional private, public and non-governmental sector representatives in the design and evaluation of their study curricula. Various universities, including Eötvös Loránd University, receive funding and content support from companies to improve their educational offer and ensure a stronger link to the labour market. With support from the regional government, the University of Bologna has engaged with three other regional universities in the co-design and implementation of an international master's programme called MUNER (Motorvehicle University of Emilia-Romagna), in light of the strong specialisation of the region in the advanced motor-vehicle industry.

As for strategies to engage with regional employers, Aalborg University publishes a guide once a year, which gives businesses an insight into the different educational programmes at the university and what skills the students in the different programmes can offer. The guide is designed so that businesses can search for certain skills and then find out which knowledge domain or specialisation they should hire candidates from. It is a way for the university to present its graduates' skills to the business community. To accommodate both students and potential collaborating enterprises, the University of Stavanger provides a service portal where jobs and trainee positions, as well as proposals for a bachelor or master thesis, and other more entrepreneurial activities are posted. Several universities, including Kaunas University of Technology, the University of Ruse and the University of Trieste organise career fairs; though depending on how they are organised such fairs may benefit national or multinational companies as well as local firms.

In many, if not most of the universities in our sample, student traineeships are an integral part of the educational offer and are a common feature of bachelor, master and/or doctorate programmes. At the University of Bologna and University of Stavanger, internships are included in most curricula and two-thirds (67%) of graduates of Aalborg University had collaborated with a company or public organisation in 2017. The dual education system in mechanical engineering at Eötvös Loránd University requires its students to participate in a 22-week-long practical training experience at partner companies. This internship is reported to lead to strong relationships between students and business sector partners in Budapest. At Ruse University around 60% of the diploma dissertation topics are realistic assignments from business enterprises. In these cases, the students have both an academic advisor and a mentor-expert from the respective company. The business experts take part in the State Exam Commissions and the diploma thesis defence sessions with an equal vote to that of the academic members of the Commission. At the University of Stavanger a large number of the bachelor's and master's theses

are written in cooperation with enterprises in both the for-profit private sector and non-profit (or not-for-profit) public sector. From the material prepared by the universities it was not possible to determine whether the collaborating public or private partners were regional, national, or foreign. In terms of the contribution to employability this may not matter, but it does in terms of retention for the regional economy. The unavailability of this information suggests a lack of interest in this type of regional impact relative to the importance given to their mission of training highly employable graduates.

Industrial doctorate programmes have been a (successful) feature of university life in Denmark, the UK and France for a long time (Hristov et al., 2016). Such industrial doctorate programmes involve a strategic research project carried out in a firm that allows the doctoral students to further develop their research training in collaboration with a university, by developing a doctoral thesis. Since 2012 the Catalan government has also run such a programme in which the Rovira i Virgili University and the Technical University of Catalunya are active participants. The programme has two main objectives: to boost the competitiveness and internationalisation of Catalan industry; and to offer doctoral students the opportunity to work on Research, Development, and Innovation projects with firms. The ZABALDUZ programme run by University of the Basque Country together with local companies or public organisations focuses on nanoscience, materials and chemical engineering – one of the region's five smart specialisations. An industrial doctorate programme has also recently been introduced at two faculties of the University of Warsaw in Poland.

The University of Strathclyde has a competitive fund to establish new Strathclyde Centres for Doctoral Training. All these new Centres for Doctoral Training require industry co-investment to ensure linkages and pathways to impact which have been particularly significant in producing highly talented people to go into new industries such as offshore renewable energy and continuous pharmaceutical manufacturing. Strathclyde University's GlaxoSmithKline PhD Partnership has direct research engagements on a range of ongoing drug discovery programmes, while training future GSK researchers. The partnership with GlaxoSmithKline involves both an MPhil / PhD programme and a Doctoral Training Centre. In addition to the £4.5 million GSK funding for this strategic partnership, there is a further £1.8 million of income from the Engineering and Physical Sciences Research Council (EPSRC) as part of the iCASE (industrial studentships programme).

In many of the RII case studies of technical universities such as Turin, PhD grants are funded by local and international firms. In the absence of formal industrial PhD programmes at the national or regional level, some universities are developing their own initiatives. At the University of Trieste, for example, PhD candidates can carry out their research project in a firm or a partner public

sector research organisation, while about 40% of the topics for the PhD programmes have been initiated by local firms.

There are large differences between universities in Europe as to the share of master graduates working in their home regions. For example, graduates from the University of Warsaw, a capital region with a large population and a concentration of public and private sector employers, are much more likely to find a job in the local region than graduates from Delft University of Technology, a smaller region in a country where employment is more dispersed across that part of the country. Such observations come with an important cautionary note: the number of master graduates working in the home region is not necessarily a straightforward RII performance indicator. It all depends on the quality and the type of jobs undertaken and on whether there is a lack of job opportunities in surrounding regions or elsewhere. Moreover, a higher percentage of graduated students staying in the region does not necessarily mean a higher contribution to regional innovation, especially if those employers are not knowledge-intensive or innovation-oriented.

6.5 CONCLUSION

Universities usually consider education as less important to their RII than research, which limits their overall impact. The RII case studies include interesting and successful examples of universities employing innovative teaching methods, including with the cooperation of firms, in order to boost employability. However, there is less evidence of universities and regions working together to develop a critical mass of talented researchers and innovators that can lead to structural change in a particular sector or smart specialisation priority domain. Such cooperation would be particularly helpful for less developed regions with closed labour markets.

The case studies also show that universities have a dual role when it comes to developing talent and human capabilities in a region. On the one hand they provide horizontal, core competences that can be applied anywhere in many different sectors and professions. On the other hand they may contribute to specific needs and issues of their home region through specialised courses (especially at postgraduate level) or through co-provision with local partners. In this regard it is important to note the increasing blurring in boundaries among different levels of education (Hazelkorn and Edwards, 2019). Universities may provide academic as well as vocational education, or provide one component of ‘dual degrees’ (courses that combine theoretical disciplines with workplace learning), which are growing in popularity. Delivering such type of education needs cooperation between organisations, in what have been called ‘skills ecosystems’. This can be particularly relevant to the regional level.

Education and human resources take a central place within the RII analytical framework. On the one hand they strengthen the university itself and the potential for improved research performance and an enhanced third mission profile (the bottom half of our analytical model). The international dimension must be underlined here, because as shown in Figure 3.1 it can be a source of human resources, in particular through migration of staff and students. However, the resources of a university become more important for the region's capabilities when they are coherent and consistent with its overall skills strategy. Regional priorities demand a range of different human resources, of which universities are only one source.

The role of education and human resources depends strongly on the type of region in which the university is located, and the case studies show that there is no single model. This should be recognised in any type of RII analysis or assessment exercise. For example, undergraduate retention is much higher in core cities, therefore in less developed regions the role of adult learning becomes even more important. These considerations feed into a region's RII profile and affect its possible pathways. We can conclude therefore that while knowledge is often referred to as place based, human capital also has a territorial dimension which needs to be reinforced for universities to increase their overall regional impact.

7. Research, knowledge creation and technology transfer

7.1 IMPORTANCE OF SCIENCE AND TECHNOLOGY FOR INNOVATION

Conducting scientific research and generating new science-based knowledge is one of the main missions of research universities. Disseminating and transferring research-based outcomes are key to translating RII potential into RII delivery. Joint research and development (R&D) programmes, science parks and other facilities have gained more and more importance in bringing together university researchers, local industry and other business practitioners. These RII pathways act as interfaces and catalysts: not only do they initiate and ease communication and cooperation, thus creating trust among partners, but they also enable and speed up the flow of ideas and knowledge, exchanges of staff, joint R&D agenda setting and sharing of equipment. There are numerous RII pathways, also for 'embodied' interactions and 'tacit' knowledge flows, where connections and partnerships range from personal ties and small consulting assignments to large, longer-term research projects.

Universities are often crucial organisations in regional innovation systems, especially in those systems with an underdeveloped R&D-led business sector or a lack of knowledge-intensive firms (Vallance et al., 2018). The knowledge generated by universities, and the transmission of the knowledge generated to local private sector actors or other (public sector) users, tends to have positive effects on a firm's innovation performance (e.g. Leten et al., 2014) and can be an important input to local or regional innovation systems. Many European research universities are heavily engaged in R&D partnerships with business enterprises – either locally, within the wider region, or abroad. More and more of these engagements occur within the context of 'open innovation' environments, where departments and units at firms interact with a range of universities and other external sources to explore and develop innovative ideas and opportunities, and exploit these opportunities through multiple channels for commercialisation. Universities themselves may also adopt 'open' approaches on how they engage with local or (inter)national partners; see for instance the cases of Aalto University and Aalborg University mentioned in sections 5.2

and 7.3. A university's integration in (inter)national R&D networks can be beneficial to local cooperation and knowledge transfer within their regional innovation system: it may often be the knowledge generated elsewhere that is of particular relevance to a partner firm within a university's home territory.

Many of Europe's largest research-active universities are closely associated with a 'science park', a 'technology park' or an 'innovation hub' (or equivalent entities under various other names). In most cases the science parks have been established by the university, often in collaboration with important research partners (such as university hospitals) and economic development partners or regional government agencies. Most of these parks or hubs have been designed with the specific intention of providing physical infrastructure for interactions between academia and industry, an environment in which academic researchers and R&D staff working in the private sector can meet and exchange with one another, which also helps to stimulate new ideas and facilitate opportunities for collaborative research. In most cases these infrastructures include 'business incubation centres' or 'business accelerator centres' designed to support innovative new spin-outs emerging from the university, start-up firms, or attract other firms from outside the local region. The creation and survival of these revenue-generating university spin-offs is probably one of the most important RIIs in terms of economic impact (job creation, revenues and profits, network and cluster effects).

Knowledge and technology transfer to firms has been institutionalised within universities through the establishment of Technology Transfer Offices (TTOs), or other types of organisational entities aimed at engagement with the business sector. These dedicated units liaise between the university and industry at different levels and can incorporate a range of functions; facilitating the commercialisation of research findings, providing advice and handling legal issues related to intellectual property, but also registering or selling university-owned patents, licensing out university-developed patented technologies to existing firms, assistance on protecting university patents, arranging joint university–industry conferences or other forums to managing joint research projects and business ventures, creation of information portals for business partners, and support of university spin-off enterprises. Large TTOs within large research-intensive universities have a range of specific full-time employment positions of experts in technology transfer, intellectual property management, and business development. Increasingly TTOs are also expected to promote, shape and implement a university's technology, innovation and commercialisation strategy; especially at those 'entrepreneurial' universities that are very active in creating new 'spin-off' business enterprises with various forms of participation of university representatives and investments.

Sections 7.2 and 7.3 further describe how R&D activities, science parks and other support facilities like TTOs help to develop and activate the RII potential

of universities in the area of research, knowledge creation and technology transfer. These sections relate to 'RII resources' and 'RII delivery space' domains in our RII model. The final concluding section summarises the main findings and draws some general conclusions.

7.2 RII RESOURCES: UNIVERSITY–BUSINESS CONNECTIONS AND INTERACTIONS

Driven by the dynamics of the corporate world, the size and shape of regional innovation systems are ever-changing. Knock-on effects on related university infrastructures and facilities are inevitable. However, amidst these changing environments, structural features of those systems tend to be more robust and stable. For example, some university–industry partners have been established many decades ago, especially if they are dominated by large R&D-active partner firms. Aalto University, for example, has a tradition of long-term research cooperation and co-creation with major companies in the region such as ABB and SAAB. It signed a ten-year strategic cooperation arrangement with SAAB in 2017, and with a total value of approximately €20 million. Other universities, such as the Catholic University of Leuven have built extensive regional networks, across many cities and closely connected to efforts to promote the region as a knowledge hub for foreign companies. Many of this university's collaboration platforms focus on its research strengths: materials science, medical technology, food and nutrition, and drug discovery in line with regional strengths (see Appendix B for more information on the RII profile of this university). The University of Aveiro is also an example of a university that organises its collaboration platforms and partner networks on a thematic basis. In this case, agro-food, multidisciplinary high-pressure, sea, moulds and plastics, bicycle and soft mobility, connected communities, forest and habitat.

Clearly, each university will define its own unique profile of university–business partnerships. In its efforts to continuously strengthen the relationship with the region's business communities, Aalborg University has developed an interactive collaboration-promoting environment, including an online platform structure for 'open Innovation licensing', where firms can increase and mature their engagement with the university over time. This facilitates a cooperative learning process and also offers a way for the many non-innovative firms in the region to start engaging in research and innovation relationships with the university. These cooperation arrangements between regional businesses and the university range from innovation workshops involving students, student projects, and internships to cooperation in clusters and networks and, especially for strong and innovative companies, more contractually binding cooperation such as industrial PhDs, technology transfer, and research projects.

Further information about this 'Aalborg model' can be found in Appendix C, the university's case study report.

Other universities organise some of their collaboration with industry through dedicated research centres. For example, the University of Bologna hosts seven industrial interdepartmental centres (CIRIs), where applied research is carried out in collaboration with local companies. These centres are part of the regional High Technology Network and are aimed at increasing knowledge transfer towards the regional industry. CIRIs are located in the five towns throughout the region where the University of Bologna has local branches. The Technical University of Turin invested €30 million to create 11 centres that perform research on 'breakthrough technologies' while sharing this infrastructure with large companies as well as small and medium-sized enterprises (SMEs). Additional programmes targeted at SMEs provide scientific tutoring and coaching services to help them develop and produce various kinds of innovative products and processes. Appendix D provides more information about the RII-relevant portfolio of facilities, activities at Technical University of Turin.

Business associations can be important intermediary organisations. Rovira i Virgili University has gradually developed a network, known as the Campus of International Excellence Southern Catalonia (CEICS), which connects business associations to its public research centres, technology centres and university hospitals. CEICS is seen as part of the broader region's Research Innovation Strategy for the Smart Specialisation of Catalonia (RIS3CAT). Further details about this CEICS and this university are presented in Appendix F.

Universities with a strong presence in the engineering sciences, or a business school on campus, tend to have a higher relative number of contacts with the business sector than universities with a relatively stronger specialisation in the social sciences, or arts and humanities. Consultancy and contract research have been a traditional channel of knowledge transfer for universities including Trieste. Services for regional firms constitute a very significant share of these contracts (43.5%), providing a measure of engagement with regional industry. More than half of the contracts of the University of Trieste involve its engineering department. As a counter example, the University of Warsaw is remarkable for its large share of contract research in humanities and social science, partially a consequence of a US$1 million grant by Google in 2013 to establish the interdisciplinary Digital Economy Laboratory (DELab). This facility has become the main hub for research into digital technologies, and their impact on economy and society within Central and Eastern Europe. Further information on the University of Warsaw's array of RII-relevant facilities and activities can be found in Appendix E.

7.3 RII DELIVERY SPACE: TECHNOLOGY TRANSFER OFFICES, PATENTS, AND OPEN INNOVATION

The RII case studies show that many research-active universities, as well as comprehensive universities, run active and dynamic TTOs. Leuven Research & Development (LRD) is a prominent example of a successful TTO in Europe; it was established in 1972 by the Catholic University of Leuven, which makes it one of Europe's oldest TTOs. LRD in Leuven is one of the biggest TTOs in Europe which supports all forms of exploitation of research results. Set up as an autonomous business unit within the university it now consists of a multi-disciplinary team of over 100 experts. The TTO manages research collaboration agreements between the university and industry, the commercialisation of intellectual property, the creation of new ventures (spin-offs) and the development of science parks. The total revenue of all LRD supported activities increased to about €210 million in 2018, part of which is used by academics to hire staff to sustain their research commercialisation ('valorisation') activities. LRD also takes an active role in influencing the development of innovation policy in Flanders, as well as in Europe. In Flanders, the regional legislation stipulates that in case of exploitation of an invention the inventors are entitled to a fair share of the proceeds. This allows the university to use a flexible and effective mechanism to provide incentives to staff – special divisions of the TTO have been set up, which are maintained independently from the central administration and act as virtual companies within the university. More information on LRD can be found in Appendix B, the RII self-appraisal report by the Catholic University of Leuven.

Over the last 20–30 years, most of the other research-active universities in Europe have also set up TTOs. For example, the University of Warsaw has now been involved in direct and indirect technology transfer processes for some twenty years. The university's Technology Transfer Centre (UOTT) provides professional services for intellectual property protection and offers support for the UW academics with patent issuing, licence granting or sale of rights. It also provides contacts and programmes for government or private funders and professional advice on academic IP protection (see Appendix F). Some of the more regionally oriented universities were later at setting up TTO type structures in their organisations; the University of Ruse and the University of Trieste in Italy established their TTOs as recently as 2008.

As universities learn from more and less successful experiences worldwide, their TTO business models and organisational structures continuously evolve and adapt. For example, the University of Bologna has been transforming its TTOs to cater for different demands related to knowledge transfer activities.

The transformation of Bologna's IPR office into a Knowledge Transfer Office also meant an expansion of the services it offered. In doing so it works together closely with AlmaCube, the business incubator of the University of Bologna. The University of Bologna is considered a reference point at national and regional level, thanks to its contribution to the development and enhancement of the university community norms and practices in terms of intellectual property rights (IPR) and knowledge transfer. It was one of the first Italian research-active universities issuing an IPR regulation in 1996. As the example of Bologna shows, it is not only the technical universities which have set up formal structures to promote knowledge transfer. Other, comprehensive research-active universities such as Aalborg University, Eötvös Loránd University and Leiden University have also set up such organisational structures.

Attaining better results in utilising their intellectual property is a major issue at several universities. Since 2006, Aalborg University has insourced the entire commercialisation process and has constrained its patenting activities to the most viable and (potentially) most profitable inventions. This strategic change is one of the main reasons why it has become the biggest seller of inventions and discoveries among the universities in Denmark – 36% of all commercialisations of research outputs in the period 2012–2016 belong to this university. Aalborg University has also established an innovation department ('AAU Innovation'), which, on the one hand, deals with the legal issues related to knowledge transfer, and on the other hand, facilitates the interaction of the university with research and education networks, local governmental authorities and local business organisations. The Open Innovation Licensing system of Aalborg University ensures risk-free technology licensing by providing a two-step process: the clients first obtain a trial licence to assess whether the invention matches their needs before signing the commercial licence (see Appendix C).

The universities of technology, several or which could also be labelled as 'entrepreneurial', have pushed their TTOs into new areas. Modern means of intellectual property management, and adopting 'open innovation' approaches, now enhance the process of commercialisation and transfer. The transformation of the Technical University of Turin's TTO into the new Technology Transfer and Industrial Liaison department constituted a reinforcement of its legal, administrative and methodological support to technology transfer activities. In 2016, the Technical University of Turin, supported by Banca Intesa and the Ministry of Economic Development, set up a project aimed at creating a unique entry point for patents filed from most of the Italian research-active universities and research centres. The objective is to provide greater opportunities for SMEs to access the pool of patents and related technologies (see Appendix D).

The Technical University of Catalunya's Technology Transfer Centre, which was set up in 1987, was complemented eleven years later by an Innovation Office to provide a fuller range of services related to the commercial exploitation of research and technology development. Also in the Catalunya region, Rovira i Virgili University produced its first spin-off company in 1998. Since then 24 more companies have been set up, of which 15 are still active. These start-up and spin-off companies directly employ around 100 people and have generated a turnover of almost €15 million over the last ten years (see Appendix F).

Universities that are active in technology transfer tend to measure their success in technology transfer activities with quantitative indicators such as the number of patent filings or revenues earned on licences. The patent portfolios of the research-active universities under study are generally reported to have evolved quantitatively (in terms of volume) as well as qualitatively (with regards to selectivity and portfolio building). As an example of the latter, the Technical University of Catalunya currently has an extensive portfolio of patent families with more than 60 'market-oriented' patents of commercial value. With more than 600 registered patents the Technical University of Turin is a leading university in Italy. About 50% of its patents are co-owned with local companies or research centres. This university has a growing number of patent (co-)applications and licences to external firms but also its university spin-offs. These activities have generated around €1 million income from different sources and around €0.7 million on patent options (see Appendix D).

Aalto University is less focused on such quantitative indicators and performance statistics for RII analytics or assessment purposes. It argues that such indicators may not be measuring real impact and may in some cases even be counter-productive. Aalto University's *Principles for Commercialisation of Intellectual Property* (2017) define the primary goal of maximising societal impact through optimal utilisation of the research results. When new inventions are made, the respective university services support the recognition and protection of the intellectual property, as well as the transfer of rights to third parties, including newly formed start-ups. In case of inventions transferred on the basis of commissioned research agreements, the partner company has ownership or access rights to the results. Aalto University understands its role in its innovation ecosystem to be different and argues that this should be reflected in assessments. It considers that "in an integrated co-creation model the focus should be on the achievements of the ecosystem as a whole", and claims that "by not focussing on maximising its own technology transfer indicator values Aalto University facilitates the success of the other ecosystem members" (Aalto University RII self-appraisal report). In the same vein Aalto University has integrated the assessment of third mission activities into its excellence evaluations both at individual researcher and university level.

7.4 CONCLUSION

The examples in this chapter aptly illustrate the variety of RII resources and delivery spaces among European research universities. Each university has its own RII profile of strengths and strategies. Nevertheless, several common enabling factors emerge that may significantly contribute to achieving successful RII. Extensive levels of industry-oriented regional engagement and involvement in regional R&D networks is one of those factors. Human capital is important: staff and students engaged in research collaboration and resource exchanges between universities and innovation-driven business enterprises is also one of the more important pathways. Physical capital, such as TTOs and business incubators, can help universities to launch their spin-off companies and create regional innovation impacts such as job creation in local communities. With such assets at their disposal, several universities are well-placed to deliver entrepreneurship support to the business sector, helping to develop more innovative and competitive firms. How universities in Europe go about their entrepreneurship education and how they support enterprise development are the main topics of the next chapter.

8. Support to enterprise development and entrepreneurship education

8.1 IMPORTANCE OF ENTREPRENEURSHIP AND BUSINESS SECTOR ORIENTATION FOR INNOVATION

One of the key assumptions underlying regional innovation policies is that universities can act as entrepreneurial actors (Power and Malmberg, 2008; Audretsch, 2014). Entrepreneurship-driven RII is likely to materialise when universities initiate economic activities or are actively engaged with business sector partners. Such connections and interactions may involve numerous organisational vehicles, mechanisms, and channels (Mustar, 2002). Supplementing the various 'transfer' mechanisms mentioned in the previous chapter, this chapter focuses its attention on entrepreneurship training and support to enterprise development in general.

To prepare their graduates for a society and economy – both domains characterised by increasing complexity, variability, and uncertainty – universities increasingly aim to provide students a suitable learning environment for those who want to start their own business venture, as well as for students that want to experience the pros and cons of being entrepreneurially engaged. As such, universities can support entrepreneurship and enterprise development in their local or regional environment. That process of creating such RII resources and RII pathways usually starts with provision of entrepreneurship education, mostly by conferring the skills, aptitude and mind-set that will enable these individuals to develop new and innovative plans (Jones and English, 2004).

Entrepreneurship includes creativity, innovation and risk-taking, as well as the ability to plan and manage projects that achieve objectives. Proactively equipping their students (or staff) with an entrepreneurial attitude and sufficient entrepreneurship competences enhances their propensity to take calculated risks and start new initiatives. During 'venture creation programmes' (Ollila and Williams-Middleton, 2011; Lackéus and Williams-Middleton, 2015; Boh et al., 2016) students have to think and act as entrepreneurs, creating real-life ventures as part of the formal curriculum. Throughout the process, mistakes are valued since they are seen as opportunities for reflection

and learning. Students also attempt to engage other internal (academics) and external (practitioners, investors) stakeholders in their venture creation (Ollila and Williams-Middleton, 2011). Another very powerful strategy for student deep learning (Bovill et al., 2011) is the practice of involving students to lead or design educational programmes.

Offering students a dedicated platform to pitch their plans and ideas to companies and potential investors can also be an important part of fostering entrepreneurship. When university students or staff become 'entrepreneurial' and 'innovative', they may interact with business of all sorts; from SMEs to large multinationals, and century-old established enterprises. Some of these firms are likely to be either a university 'spin-off' or 'start-up' firms (spin-offs are supported by university-owned intellectual property; start-ups are not). Innovation-oriented entrepreneurship may lead to new products and services with potential value for commercialisation in the regional economy and creation of significant levels of RII.

However, entrepreneurship is more than learning the skills to setting up or running a business venture; it refers to the generic capacity to act upon ideas and opportunities to generate social, economic, and cultural value. Entrepreneurial activities might involve the knowledge and the skill set of multiple fields of knowledge. Such 'entrepreneurial human capital' does not necessarily only prove its value in the number of new business enterprises that were launched or other economic ventures. Entrepreneurship competences can be employed in almost any circumstance and profession, including in not-for-profits, government organisations, the education sector, and in large enterprises. In other words, having entrepreneurship skills also helps to empower university graduates or staff members to pursue self-directed career management.

This chapter is specifically dedicated to the 'RII delivery space' of universities, in particular its RII pathways. Section 8.2 describes initiatives, activities and pathways related to entrepreneurship education, while section 8.3 presents examples of how universities may support business enterprise development. The concluding section summarises the main findings and draws some general conclusions.

8.2 RII DELIVERY SPACE: ENTREPRENEURSHIP TEACHING AND TRAINING

Entrepreneurship courses are designed to raise awareness with regards to the possibility of becoming an entrepreneur – either as a student or after graduation. Over the last two decades, many research-active universities have introduced entrepreneurship courses and facilities for student-led entrepreneurial activities, which may attract talented students, entrepreneurs, and investors. Some of the universities represented in our case studies have set explicit

targets in their visions for the near future. Aalborg University's vision for the next strategic period (2021–2026) states: "all students must graduate with the knowledge and skills to create their own company" and "a goal is to create 1 000 entrepreneurs" (see Appendix C, section C.5).

Various teaching approaches are used by entrepreneurship education providers, such as Problem-Based Learning (PBL) as described in Box 5.2 (section 5.2). The University of Strathclyde's Hunter Centre runs Enterprise Clinics, delivered by cross-disciplinary teams of Business School students who conduct research and consultancy projects for local businesses facing specific challenges. Aalto University has introduced the Berkeley Method of Entrepreneurship to develop new teaching models. Aalto University's entrepreneurship programmes build on entrepreneurship-related collaboration with the University of California Berkeley and Stanford University (both pioneers in university-based innovation systems). The Aalto Ventures Programme offers its students entrepreneurship courses – taught by professors, venture capitalists, and entrepreneurs – with a focus on building scalable businesses.

Integrating entrepreneurship education in the curriculum of other study programmes is a common feature in many universities. For instance, the University of Leuven offers entrepreneurship courses to bachelor as well as master students. It's LCIE academy portfolio is created so that students are required to take a variety of courses from different faculties, thereby promoting interdisciplinarity as one of the core values of innovation-driven entrepreneurship (LCIE is KU Leuven's 'Community for Innovation driven Entrepreneurship'). Another initiative was developed by students from the law faculty of the Catholic University of Leuven who established IusStart, a legal clinic run by PhD students, in which law students as part of their studies provide legal advice to other students who work on the development of their start-up firms. Similarly, technology advice is shared by PhD students from the engineering faculty under the 'TechStart' project. When rolling out the student incubator activities at the Catholic University of Leuven, it was decided to provide facilities for student-entrepreneurs in a decentralised way, across the various campuses. The facilities include a 'fab lab', providing students with the necessary prototyping tools. Students interested in entrepreneurship can access a 'creativity lab' where they can meet and work on their business plan. Office space at an incubator facility, which is shared with young start-up companies, allows students to interact with other entrepreneurs. See Appendix B for more information on this university's activities with regard to entrepreneurship teaching and training.

Each university has its own organisational structure to facilitate entrepreneurship education and training. Not only does Aalborg University offer more than 100 different courses or study programmes on entrepreneurship for students, entrepreneurial activities are also incorporated in the regular curricula to

prepare students for work in the business sector. Aalborg University's business developers worked with many students (see Appendix C).

By way of its European Innovation Academy, the Technical University of Turin hosts an intensive summer entrepreneurship school in which about 500 international students (including its own students), guided by renowned mentors and with the sponsorship of multinational firms and international organisations, are challenged to transform their ideas into technology start-ups while working in a multidisciplinary and international team (see Appendix D). The Technical University of Catalunya runs an initiative called an Innovation Office that aims to foster an entrepreneurial culture among students and help them create new tech-based companies.

Another example is the Centre for Entrepreneurship established by Warsaw University, which, among other activities supporting entrepreneurial education, hosts the annual international conference on entrepreneurship that gathers both business and academic communities. The University's Technology Transfer Centre also launched the UW Incubator (IUW) dedicated to supporting entrepreneurial skills among students and alumni as well as accommodating entrepreneurial ideas of staff. A network of faculty ambassadors was created for 21 departments and almost 100 mentors were invited to support students' ideas. IUW offers science–business co-working space and development of social entrepreneurship facilities for students (see Appendix E). The University of Ruse's Centre for Entrepreneurship Promotion, in cooperation with its Technology Transfer Office, runs an Entrepreneurship Development programme which is supported by a variety of funding sources. Start-up training is open to all students, regardless of their degree programme, offering several business start-up courses. Over the last three years, the university has also initiated and organised the Innovative Youth EXPO, where student teams present their innovative ideas and developments. The Innovation Lab at Eötvös Loránd University's Faculty of Informatics is another example of a facility specifically designed to assist the development of innovative entrepreneurial ideas of students (and university staff). Participants can start their own start-up projects or may join other start-ups to develop entrepreneurial ideas. The University of Bologna supports entrepreneurial ideas of their students during its StartUp Days, a round table during which the students of pre-selected projects pitch their ideas to regional, national, and even foreign investors. The annual series of these events (held since 2015) involves 838 start-up projects, 126 of which received customised support and 100 entered the incubation programmes of AlmaCube. So far, more than €3 million have been raised by the companies that participated in StartUp Day events.

Experienced coaches are essential to nurture student entrepreneurship. Leiden University's ELF pre-seed fund gives students access to a network of relevant experts and contacts in Dutch and international companies and

organisations, both within and outside Leiden. These experienced business people help them to let their idea grow, and can provide them with the financial and physical resources to turn their business idea into a solid business plan. The Norwegian University of Science and Technology launched Spark*, a student-driven extracurricular entrepreneurship initiative. All university students with an idea they want to set to life are eligible for free coaching by students with some previous entrepreneurial experience (e.g. owners of start-ups) or by its senior staff. So far, the initiative has offered coaching to over 360 projects and supported over 1 100 students. Among the projects 36 have been turned into businesses. Mentoring can be provided both by senior students or staff as in the GUIDED programme at Kaunas University of Technology which involves an educational partnership between a motivated student and a more experienced and competent mentor. One of the most valued aspects of university support for student-entrepreneurs is access to facilities such as meeting rooms and workplaces. In 2017 the University of Trieste launched a contamination-LAB with 1 000 m^2 of co-working space where students can develop entrepreneurship skills. Some universities have joined forces with other regional partners to provide its students with the necessary entrepreneurship skills: Leiden University, the municipality of Leiden and the University of Applied Sciences in Leiden have jointly set up a pre-incubation facility called PLNT, which hosts courses and events for and by students aimed at fostering innovation and entrepreneurship. PLNT also houses start-ups and professionals who can support student entrepreneurs.

8.3 RII DELIVERY SPACE: SUPPORTING ENTERPRISE DEVELOPMENT

The available support structures at universities differ significantly in size and scope. Some are large and have evolved for several decades, while others are relatively new and small. The Catholic University of Leuven has invested substantially in its own science parks, business centres and incubators since the mid-1990s. The university's 'Leuven Technology Corridor' comprises several locations, all in the immediate vicinity of Leuven. The Arenberg Science park is located next to the science campus, covers 13 hectares and will ultimately consist of four clusters, each offering 25 000 m² of working space. The Catholic University of Leuven has spun-off no less than 124 companies during the years 1979–2017. In the period 2005–2017, the university invested €32.9 million in its spin-offs, while third-party investors matched this with €926.5 million. These new venture creation activities have resulted in about 6 700 new jobs. See Appendix B for more details about the Catholic University of Leuven's achievements.

Some of the other research-active universities have also generated significant numbers of new jobs in the local region. The Technical University of Milan's PoliHub company provides support to high innovative start-ups. Since its foundation in 2000, it has collected more than 10 300 innovative ideas and it has supported about 450 of them in their start-up phase with a survival rate of 85%. Collectively, these start-ups have generated a cumulative turnover of €30 million and have employed over 550 people.

In 1998, the Technical University of Catalunya launched the Innova Programme (now the Innovation Office) to support the creation of technology-based companies and promote a culture of entrepreneurship and innovation. Of the 300 companies created during the last ten years, 80 are university spin-offs. The university holds an equity stake in 28 of them, representing an amount of €36 million; these companies employ about 300 people. Another 150 tech companies are being incubated in its Research and Innovation Park, which employ 4 000 people, 60% of whom are graduates and PhD holders.

Another example is I3P at the Technical University of Turin. I3P is the university's non-profit joint-stock consortium that includes the Turin Chamber of Commerce, the City of Turin and the Province of Turin as shareholders. I3P has been successful in introducing new companies with a significant impact on the local economy and on employment: total turnover and employment stood at €124 million and 1 687 jobs in 2016 (see Appendix D). The University of Trieste's spin-off companies are located in Area Science Park or in the Business Innovation Centre. At the end of 2017 it had 20 active spin-offs, with a turnover of almost €11 million in 2016 and directly employing more than 130 people.

Although sheer volume is not indicative of commercial success or economic impact, the number of spin-offs and start-ups may partially reflect a university's RII performance. The University of Bologna has produced 67 spin-offs between 2000 and 2013, Aalto University managed to produce about 70 start-ups annually between 2010 and 2014, up to around 100 in the most recent years (50% of all start-ups originating from Finnish research-active universities annually). The University of Strathclyde's Hunter Centre for Entrepreneurship, collaborating closely with its TTO (Research & Knowledge Exchange Services) and the Strathclyde Entrepreneurial Network, has helped to support the formation of over 150 companies through its Enterprise Hub since 2005.

Business incubators and accelerators are important facilitators in a university's RII delivery space. Validé, the University of Stavanger's TTO and incubator centre, handled 50 new companies. Two business exits were carried out in 2017, which resulted in a sale of NOK 11.4 million in shares. University of Aveiro's Business Incubator (IEUA), created in 1996, develops activities that

allow the conversion of knowledge into economic value, providing a business incubation programme (IEUA Start) and a business acceleration programme (IEUA Graduate). In 2017 IEUA developed 30 companies, of which 27 were in incubation or acceleration stages and responsible for a turnover of €8.8 million and 153 jobs. The University of the Basque Country hosts six business incubators in the three Basque provinces (three in Biscay, two in Gipuzkoa, and one in Araba) and each year allocates €12 000 in prizes to award the most innovative ideas and the best university entrepreneurship projects.

8.4 CONCLUSION

A university's economic impact is intricately linked to its ability to foster 'knowledge intensive entrepreneurship' (Malerba et al., 2015). Developing an entrepreneurial mind-set and skill set is a necessary condition to prepare university students and staff for setting up companies or gaining employment in the business sector. Innovation is, ultimately, about the human factor, about individual entrepreneurship, creativity, and persistence.

Several universities are genuine 'engines of innovation' in terms of producing spin-off and start-up companies over the years, with many new jobs created in knowledge-based industries. The examples, however, also underline the major importance of physical infrastructures and dedicated facilitators within RII delivery spaces, such as science parks, business incubators and business accelerators. Successful RII delivery spaces require dedicated human capital and effective physical capital. Adequate funding and targeted policies are the other two pillars; these are the main topics of Part III.

PART III

Towards implementation

RII is about a university's regional engagement and outreach, about alignment with its regional innovation system. RII is much more than developing productive 'impact pathways' within universities or setting up effective 'impact delivery spaces' with useful contributions to society and the economy. It is also about a university's ambition to help create such innovation systems. To grasp such complexity, analytical frameworks and RII assessment frameworks must consider multiple perspectives: that of the university, its institutional stakeholders including regional firms and funders, as well as civic society representatives or local citizens. Integrating such a wide range of perspectives, in a properly contextualised and meaningful manner, is a demanding task. The results of our pilot study among universities in Europe, presented in Part II of this book, suggest that it is possible to gather RII-related information from universities by using a 'narrative with numbers' template. Turning principle into practice, how plausible is it that this approach can also be applied in settings where a university's RII potential or its RII performance are monitored or assessed?

Chapter 9 is devoted to a critical analysis of our case study material, where we point out the analytical strengths and shortcomings of university self-appraisal reporting on RII. There is not only a case to be made for embracing the notion of RII for organisational learning processes, but also for engaging in RII self-assessment for universities and its stakeholders – including funders. We advocate the use of external assessments to incorporate the external user perspective. The complementarity of self-assessment and external assessment offers a more comprehensive view and better understanding of RII profiles and performance levels. Implementation of assessment frameworks depends on the objective at stake; it ranges from light-touch 'descriptive' self-appraisal reporting about a university's RII potential to a more exhaustive 'evaluative' self-assessment of its RII performance. It could be a straightfor-

ward self-assessment application with a toolkit of customised indicators, or a sophisticated mixed-method, multi-stakeholder review by an expert panel.

The type of assessment and its objectives differ per type of user – be it universities, governments or funding bodies at the international, national or regional level. Chapter 10 focuses on the potential applications of RII assessment within European policy development, more specifically the importance of incentive systems to steer and boost RII performance within universities. We discuss various possibilities for designing or implementing such systems, framed within the context of European Commission policies and funding instruments.

Chapter 11 concludes by pointing out that before our multi-purpose RII framework can be used to facilitate a range of applications, we need further alignment and mutual understanding between universities, local and regional authorities, and other partners. Looking into the future, RII performance would greatly benefit from effective incentive systems but also from the availability of high-quality information systems on RII potential and pathways.

9. Realities and complexities of RII analytics and assessment

9.1 REFLECTION ON UNIVERSITY SELF-APPRAISALS

The findings of our 'proof of concept' pilot study were encouraging, offering relevant insights and avenues for further development aimed at possible applications as an assessment tool. The presented self-appraisal reports in Part II, admittedly still only a very small sample of all research universities located in Europe, has revealed the strengths of our analytical approach, but also room for improvement and further development.

Starting with the strengths, the rich and varied content of those self-appraisal reports contain informative backward-looking accounts of their current RII-relevant activities and organisational processes. They describe important aspects of their RII potential and mention RII relevant pathways, while several highlight their RII achievements or how they engage with local or regional authorities and stakeholders. The five case studies presented in the Appendices are interesting illustrations of how their 'narrative with numbers' capture these different perspectives. Naturally, their retrospective accounts reflect prior decisions and chosen trajectories, which are not necessarily indicative of new developments or longer-term plans. Following the guidelines for the self-appraisal reports (see Appendix A), universities also incorporated a forward-looking perspective, which provides some relevant information on possible future developments and strategies for improving their regional engagement.

The universities were able to assemble a variety of information from in-house sources on attributes or components of their RII profile. The 20 self-appraisal reports offer valuable insights as to which elements of information are used by universities to describe important components of their RII profile. Our content analysis of these reports produced more than 400 references to distinctive elements. In that sense, the analytical framework also seemed to work reasonably well as an information gathering tool with regards to possible 'indicators' (proxy measures) of RII potential or performance. We refrained from analysing those elements in terms of their relevance and

validity as an indicator. We simply tallied the number of references, thus ascertaining which elements are most frequently used and could possibly constitute a 'fit for purpose' indicator in the eyes of universities. Some of those indicators are 'generic' – they occur quite often and refer to common characteristics of RII-oriented universities, such as 'the presence of a technology transfer office'. Depending on the university's RII profile and the RII absorptive capacity of its local or regional environment, some of the indicators are university-specific – for example 'Co-working and co-creation spaces' in the case of universities in metropolitan areas with a large services sector or 'arts and culture' sector. Half of all indicators mentioned are 'background indicators', which do not specify the university's role in the local or regional environment. These indicators may reveal valuable information on the university's RII potential, but nothing on RII competences or achievements. For example, we find indicators of university–business cooperation without information about where the partner firms are located or whether such collaborative activities are relevant to local or regional economic goals. In our RII model, set out in section 1.4 (Figure 1.1), such background indicators could perhaps feature as an RII pathway indicator, but need more detail and specificity to count as an RII indicator. The other half are RII-specific 'foreground' indicators, those that do reflect the university's local or regional focus. But very few of those were 'quantitative' indicators (see Table 4.2 in section 4.3). There are far more references to RII-specific 'qualitative' indicators, such as a commitment in a university's mission statement to strengthen regional economic development. The relative scarcity of 'quantitative' indicators not only reflects the absence of RII-specific information in university management systems, but probably also difficulties to link facilities, initiatives, or activities within the university to possible impacts in a specific geographical area. In both cases, it raises the question of which dedicated resources and incentives are needed to remedy this information gap. Especially in the case of larger universities, their societal mission, organisational infrastructure, and portfolio of activities are likely to be too broad and diversified to be pinned down in terms of the geography of impacts. The prism through which they view the varied outreach of their organisation is not necessarily space/place-bound in terms of clearly demarcated surrounding territories. Even so, large research universities that have invested heavily in infrastructures, facilities, programmes and projects specifically dedicated to engagement with the local surroundings, and aiming to create significant levels of RII, should be able to generate a wide range of high-quality RII-relevant information for monitoring and assessment. In order to bridge the observed information gap, universities should be incentivised to collect more information on observable effects of their investments in regional engagement and outreach, especially those outcomes with significant

and measurable impacts on the local business sector and regional innovation system.

As for possible improvements, further steps are clearly required to upgrade the analytical framework. Not only to test its practical feasibility as an information-gathering tool and for analytical purposes, but also to determine the framework's value added for designing or supporting evidence-based policy initiatives. These follow-up studies will have to confront several technical, methodological or organisational issues, but also address a series of more fundamental questions: how relevant and useful are the self-appraisal reported facts and figures in their 'narrative with numbers' reviews? Does the proposed analytical framework live up to expectations from stakeholders when applied to performance monitoring or in evaluative settings? Is the approach appropriate for in-depth self-analysis for gaining insights into RII potential and performance, such as the impact of motivational factors and incentive systems? As is to be expected in such time- and size-constrained self-appraisal reports, some features of the university's RII profile will inevitably remain obscure. Although a few of the surveyed universities may have implemented incentive and reward systems to engage in local or regional orientation, outreach or cooperation (see section 4.2), they refrain from addressing the (possible) effectiveness of those measures. There is no mentioning of RII performance targets or stakeholder expectations concerning investments in engagement-supporting resources. Although many universities collect in-house information on various aspects of their regional engagement (see section 4.2), it is not clear if and how such information is made accessible for application outside the university management domain. Nor are there any studies within universities to assess the effectiveness of their regional engagement activities and investments.

Furthermore, something else and more fundamental is also missing – both in the self-appraisal reports by universities and in our framework. To describe that deeper gap, let us briefly return to Part I of this book, where we presented our analytical model (Figure 2.1, section 2.1). It specifies inputs, stages of development and processes that seem to follow pre-determined 'linear' paths or 'non-linear' feedback loops, where ultimate achievements and impacts may, or may not, reach users in the local environment or spill-over beyond the geographical area. This particular model is of course a crude reflection of complex and dynamic realities. Importantly, it cannot incorporate chance events, coincidence and serendipity. Some RII processes or events can be largely attributed to deliberate intent, others are mainly determined by randomness. Moreover, whatever the university does or does not do, we can never be certain of what will happen, or could have happened, in terms of alternative regional engagement trajectories or RIIs. Hence, we are in the dark about possible options or missed opportunities that a university could have pursued to (further) develop RII potential or enhance the effectiveness of its RII delivery space. Should

comprehensive RII models aim to capture the role of unexpected external developments, organisational 'optionality' and 'what if' counterfactuals? One can easily dismiss this as an inevitable shortcoming, given the complex dynamics of environments in which universities operate, but including the fundamental notion of uncertainty in the model would help to present a better contextualised account of RII success stories and failures.

9.2 FROM ANALYTICAL FRAMEWORK TO ASSESSMENT FRAMEWORK

Our 'narrative with numbers' analytical framework seems to work reasonably well as a self-appraisal reporting tool but is it also useful for RII assessment? For such applications we are still at a very early stage. Assessment frameworks need careful consideration and a robust design to avoid implementation problems that one could encounter when adopting a more critical stance. Verifiable narratives are needed. And more numbers, especially those that can be verified. Moreover, a poorly designed framework can reinforce existing power structures within universities or their RII systems, thereby perpetuating 'old ways' of RII-related thinking, incentivising and acting. For example, one should avoid an overemphasis on 'RII endpoint assessment', which ignores the many mitigating factors that might have contributed to a university's success or failure in an RII trajectory. RII assessment should be primed to carefully consider the entire setting surrounding the performance of an RII pathway, an intermediate outcome, or an RII itself. The aim should be to recognise and identify, as much as possible, the particular circumstances or major contributing factors that may have contributed to the identified output, outcome or impact. This kind of approach, which may include counterfactual thinking, enables a contextualised analysis of RII practices, processes, and causation, rather than an almost myopic focus on ultimate outcomes or impacts. Clearly, such an assessment toolkit requires a customised set of indicators and expert judgement.

High-quality assessment frameworks should also balance their level of 'inclusiveness', that is, capturing as many (potential) impacts as possible, but weighed against the operational costs of information gathering. Overly ambitious assessment exercises are not cost-effective. Many universities are already overloaded by administrative and bureaucratic pressures, being subjected to streams of compliance-driven information requests from governments and other agencies. A workable analytical framework should be as 'light' as possible administratively, in order to keep the data collection efforts and reporting burden at an acceptably low level. Ideally, such RII information demands should be coordinated and synchronised between the university and its key 'external actors'; local or regional authorities, other RII relevant part-

ners or funders. To organise implementation processes, we need to distinguish between four main modes of assessment: internal versus external, and summative versus formative. The first dimension relates to the actor conducting the assessment, the second dimension describes the assessment's main analytical perspective.

Figure 9.1 presents a stylised overview of those four assessment modes, each described in terms of analytical framework attributes and performance parameters from Figure 2.1 (section 2.1). Rather than polarising between the different modes, this diagram is meant to emphasise similarities and overlaps: some 'integrated' assessments may involve internal and external views and information, other assessments may include both backward-looking and forward-looking elements. Where summative assessments are outcome-oriented and often backward-looking, aimed to identify and learn from observed strengths and weaknesses in the university's past performance, formative assessments are process-oriented and geared towards generating ideas and collecting information on opportunities and challenges within the university. The distinction between summative and formative also defines the nature of relationships with the external stakeholders concerned. In those cases where RII self-appraisal reports or self-assessments inform external RII performance reviews, the interactions with stakeholders are likely to be more intensive and focused on meeting assessment requirements (like providing verifiable proof of RII achievements).

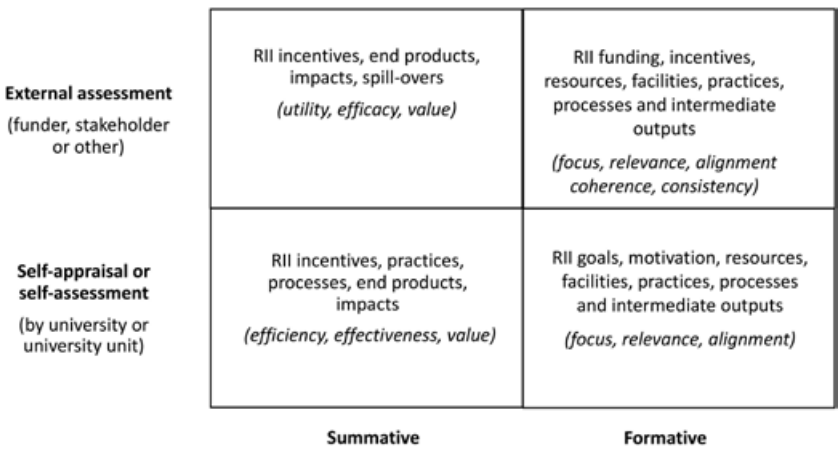


Figure 9.1 Four modes of RII analysis and assessment

Most of the information presented in this book are summative self-appraisal reports and fall in the lower left-hand quadrant. Those assessments should

focus on issues of efficiency, effectiveness, and value – in other words, how well has the university done in terms of creating (opportunities for) RII. Several important attributes and parameters are indeed dealt with in those self-appraisal reports, but many are not (well) covered. Information on final impacts, and the effectiveness of the universities' activities and investments receive much less attention. This leads to the question of how informative those self-appraisal reports are in terms of their overall value for assessment? This topic is addressed in section 9.3. The other three quadrants, especially the top quadrants (external assessment), are further introduced in section 9.4 where the added value of incorporating other perspectives in RII assessments is discussed, especially those of expectations and accountability vis-à-vis external funders and stakeholders of universities.

9.3 FROM SELF-APPRAISAL TO SELF-ASSESSMENT

Recognising the fact that each university is distinctly different in terms of 'scale and scope', and acknowledging that their RII profile is characterised by its own unique interconnected mix of 'space, place and resource' parameters, what can we expect from RII self-appraisal reports? As explained in the previous two sections such analytical exercises have to deal with complexity and uncertainty. Information on organisation-level RII profiles and portfolios is, by definition, incomplete and usually retrospective. There is no hope of capturing all RII relevant information on a university's organisational constraints or opportunities. Facing these inherent limitations, how likely is it that self-appraisal reports will be able to deliver at least some essential information on their RII potential and performance? What can one expect from 'narrative with numbers' accounts in terms of information value?

Most of the self-appraisal reports presented in this book tend to focus on high-profile success stories, stress the university's organisational strengths, and introduce grand ambitions for further development. Producing such self-appraisal reports, often within a relatively short space of time, illustrates the ability of universities to access internal sources and deliver RII relevant information that complies with external specifications. Moreover, the response rate and information value of the empirical material supplied by universities implies that they are able to translate the concept 'regional innovation impact' into internal organisational structures and concrete activities. Judging by their input for each of the four pre-defined RII domains, these are also seen as meaningful from the university perspective.

Furthermore, most self-appraisal reports remain 'broad stroke' descriptive overviews, rather than analytical and detailed narratives. That is understandable in view of the instructions and size constraints imposed by the editors (see

Appendix A) which forced universities to be selective and report succinctly. But, from a more critical viewpoint, we see that the quality of the information varies significantly per university and per domain. We may assume that this outcome reflects the scarcity of available information within universities, or a lesser sense of urgency to invest in gathering such information. Obviously, data collection efforts and subsequent reporting may come at considerable cost in terms of resources, which some universities can afford more easily than others.

More extensive assessment reports, and more resources for information retrieval or gathering, would be helpful to address such issues. Ideally, some information should be unearthed on underpinning causal mechanisms, pointing out the most productive RII practices or pathways, or attributing high-profile RIIs to all the primary contributors within a university. For instance, such advanced 'narrative with numbers' would allow universities to both contextualise their performance (e.g. relative to the absorptive capacity of the region and surrounding economy) while explaining, for example, why results that appear to be negative, when considering only the numbers involved, may actually be positive and in line with the university strategy.

Contextualisation is essential for interpretation of the 'numbers' and drawing meaningful conclusions from the available statistical data. The specific type of university and its geographical location should be factored in. Universities should supply sufficient data on their size in terms of organisational capacity in both education and research, an important parameter to determine the scale of RII potential and possible scope for RII performance. It is imperative that data produced by universities are supported, as much as possible, by related data from local or regional authorities, especially with regard to their innovation capability and RII absorptive capacity.

National institutional and regulatory contexts may also affect the type of RII activities a university is able or allowed to develop. When looking at the possible driving forces of RII, especially political pressure from regional authorities and domestic funders, a 'crisis driver' such as economic decline is likely to stimulate universities to enhance their public commitment. Even so, most universities will have several barriers to overcome should they decide to step up their regional engagement activities. Can they, for instance, overcome a lack of resources to create effective RII pathways, or overcome their own internal tensions in trying to achieve multiple (perhaps competing) missions? And how to do deal with the 'regional innovation paradox' in economically lagging regions, where the need to invest large sums of public investment in innovation capability conflicts with the region's capacity to absorb these funds (Oughton et al., 2002). Such 'peripheral' regions may also suffer from what is referred to as 'institutional thinness' (Tödtling and Trippl, 2005) characterised by relatively weak business sectors or fragmented industrial clusters as well as

a lack of public and private organisations that may actively promote or support university-supported innovation (Zukauskaite et al., 2017). The thinness of innovation systems could also make it easier to assess and monitor a university's RII. In highly developed regions with very 'thick' systems, comprising many higher education institutions and many business sector players, it might be more difficult to single out the impact of a single university.

The question of how to stimulate a thin system by a good university is very pertinent, especially if there is only a weakly developed external demand for university educated graduates or for other services. But if the region's absorptive capacity is at a relatively low level, with few suitable external partners, it may be unreasonable to expect universities to create sustainable RII-conductive environments. We therefore need to be realistic with regard to RII performance. Most universities are not 'RII challenge' driven, and many of them probably never will be.

Universities may operate in environments which impede them to fully develop their RII potential or prevent them from generating any significant level of regional engagement (Kempton, 2019). These obstacles may be 'internal' to the university (legal, organisational, financial, or others) or may relate to 'external' factors within their municipality, metropolitan area or region (such as regulations, governance structures, insufficient absorptive capacity). These inevitable 'background' characteristics and barriers need to be made explicit and explained in high-quality RII self-appraisal reports. Context-sensitive assessments should take such circumstances into account, as well as the vision, mission and strategies of universities to overcome external challenges and internal obstacles. As discussed in section 3.2, the RII analytical framework (Jonkers et al., 2018), needs to be expanded and include the development of a 'Theory of Change' (ToC) in which the university explains its current strategy to achieve RII-related objectives (see section 3.2). In fairness to the universities that produced the self-appraisal reports, it is important to stress that the current list of general questions (see Appendix A) should be supplemented by 'evaluative' questions that target organisational self-enhancement, where the university would be queried about the targets they set themselves in terms of specific RII performance, who should be asked to analyse and explain their RII performance, but also the barriers they face and their strategies to overcome them.[1] The final list of such questions will depend on where and how the

[1] The Institutional Evaluation Programme by the European University Association (www.iep-qaa.org) includes the following set of performance-enhancement oriented questions:

> What is the university trying to do in terms of improving its RII performance? (mission and objectives);
> How is the university trying to do it? (policies and processes);

analytical framework is implemented. More specifically, it will depend on the nature of the funding instrument to which it would be tied (see Chapter 10).

Truly informative 'deep' assessments should venture even further and try to collect data on RII relevant investments or strategies that did not (yet) produce the intended or anticipated results. Not only because such in-depth information would highlight those RII pathways that might be underdeveloped, but it may also indicate where (additional) in-house incentives and reward systems may create significant positive effects on RII performance. These insights, when properly contextualised and interpreted, would allow universities to develop better strategies and more effective practices to improve future RII performance. Detailed information on successful RII cases that occurred under less favourable regional conditions could also provide informative messages. Furthermore, time-dependent and context-dependent 'impact story'-type of information, on the chronology of key events leading up to an RII, would offer the opportunity to gain insights into the nature of processes and causal relationships.

An analytical framework should not just monitor and evaluate the impact of universities on their local environment, but also lead to an evidence base for more targeted decisions and priorities. RII-funding applications from universities (and regional partners) should provide persuasive narratives on RII potential, with relevant indicators and convincing numbers. Most universities will need to upgrade their internal information systems and management administration to gather the required RII data and background information for monitoring and evaluation. By adding the narrative part and a university-specific Theory of Change, the framework would enrich usual methods, such as counting patents, spin-off firms or student internships in the region, with facts that statistical data alone cannot easily capture. Narratives may offer deeper insights into how RII related initiatives and activities are progressing and the role of the human factor. Such a framework should be highly sensitive to the diversity of universities. It should weigh RII performance against the characteristics of the region in its actual state of development. If coupled with a multi-annual funding instrument as discussed in the next chapter, the framework has the potential to shift the attention of 'global' research-intensive universities to their regional roles, as well as help re-balance EU and national-level innovation policies that have been rendering the regional engagement missions of universities less prestigious than boosting their national visibility or international reputation.

How does the university know it is working? (monitoring and quality assurance); How does the university change in order to improve? (capacity for change).

Clearly, the self-appraisal reports presented in this book have barely scratched the surface of what is happening across research-active universities in Europe. The current version of these self-appraisal reports will not plug the information gap on a university's RII performance, but may certainly help to bridge it. Adding evaluative questions about RII performance will narrow the gap but will not close it. We need to wade further into the unknown and expand our evidence base beyond the institutional vantage point. We need to supplement university self-assessments with external assessments.

9.4 EXTERNAL ASSESSMENT

RII self-appraisal reporting represents a one-sided view. Grasping the spectrum of its RII portfolio can be a daunting task for any university, if only because it requires information on achieved impacts. Inevitably, most of those impacts have occurred outside, often beyond the university's observational horizon. Any relevant external information to supplement the organisation's perspective is therefore likely to be helpful. Detailed information from reliable, independent sources is especially important. Such inputs may bring new perspectives on a university's RII performance, raise important questions about the usefulness of indicators, or point out overlooked possibilities for impact monitoring. The process of moving from self-appraisal to external assessment will require the selection of suitable quantitative and qualitative indicators, to fit the 'narrative with numbers' approach outlined in this book. Such indicators should be useful for university management applications as well as provide a meaningful breakdown between RII potential and RII performance. Part of the problem in selecting or customising those indicators by universities could be solved if they knew about the assessment criteria in advance. Guidance would need to be provided to external evaluators to ensure that they have all the information required to make an accurate and appropriately contextualised RII assessment.

External assessments can add significant informational value to university self-assessments; they are in fact essential for user-driven *ex post* assessments of RII performance. How then to value, or critically appraise, the benefits of such external assessments? There is obviously no 'one size fits all' external assessment framework. It requires tailored 'case by case' approaches, not standardised 'box ticking' exercises. It is also clear that university-generated narratives with numbers are a key input and will then have to be accessible and understandable for external users and reviewers, notably their regional partners and local civic society. Major institutional stakeholders or funders may also want to provide relevant feedback. All that information is vital to fully assess and contextualise a university's RII potential and performance within a larger setting of economic development and societal needs. Alignment

of information from such external sources with the internal information from self-appraisal reporting, requires a joint 'integrated' framework based on a shared understanding of a university's RII ecosystem, guided by a 'dialogue model' of engagement to obtain a comprehensive overview of a university's RII profile.

As indicated in the model of the RII analytical framework (section 2.1, Figure 2.1), a full scale RII assessment would also include input from local or regional authorities/partners as to either the utility, efficacy or the value of a university's 'RII delivery space'. Incorporating such information creates a range of options for assessing the university within its broader RII ecosystem as wider impacts (section 3.1, Figure 3.1). Such an external assessment would relate to RIIs directly originating from universities, those where the university was indirectly involved, or specific RII pathways with a significant impact. The two key questions at the top of the list in many of those ecosystems: are there RIIs that significantly contributed to our local or regional economic competitiveness? How can a university contribute to student employability in the region?

While most research-active universities are conditioned to accept external reviewers when it comes to the assessment of their academic performance (including scientific impact), it is less clear to what extent this willingness holds when it comes to expert review panels to assess RII, which is a new and still ambiguous evaluation object. The notion of 'innovation impact' is not as well understood as 'scientific impact'. Moreover, external experts are not necessarily good at judging the value of socio-economic impacts, let alone the relevance of RII potential, practices, pathways or performance. Clearly, external experts with specialised knowledge will be required. An expert panel should be sufficiently broad and diverse to incorporate the necessary differences in disciplinary background, sufficient knowledge of the entire university and its region, as well as an appropriate skill set. The fact that the key concept 'regional innovation impact' may not be understood the same by all experts, suggests the application of expert panel reviews in external assessments. Such panels allow for contesting and conflicting opinions which can be played out and negotiated to reach better understanding and consensus (Derrick, 2018). External assessments would be strengthened by including interviews of representatives of universities for fact-checking and gathering essential background information.

10. Policy development and strategic implications

10.1 RII INCENTIVES AND PERFORMANCE ASSESSMENT

The previous chapters were mainly concerned with *analysis*, *appraisal* and *assessment*. This chapter focuses its attention on issues of *allocation* and *accountability* – the policy dimension of RII enhancement programming. How should public funds be distributed to universities and their partners?

As discussed in the preceding chapters, innovation systems are complex and dynamic social systems. Chance may play a major role in whether specific university actions contribute to major innovations. RII successes and failures are therefore hard, if not impossible, to predict or foresee. What works at a specific university or in a particular region may not work at another university or region. Their RII-related infrastructures, capacities, processes are therefore time-dependent and context-dependent. This does not mean RII outcomes are beyond the scope of policy interventions, or that RII funding programmes are futile; universities with a region-centric portfolio of RII pathways and dedicated strategies to create RII with those facilities, enjoy a much larger probability of success. Supportive regional framework conditions, with dedicated EU funding, can make a big difference in terms of boosting RII capacity and generating RII.

Many universities in Europe could contribute more to innovation systems within their home town, metropolitan area or surrounding region. They should sharpen their focus on creating local value, where RII-oriented activities could either kick-start new initiatives, or act as a catalyst or accelerator of ongoing efforts within universities towards regional economic development. The EU policy documents discussed in section 1.2, such as the policy recommendations of the 'LAB – FAB – APP' report (Lamy et al., 2017) and the report by the RISE high-level expert group (European Commission, 2019b, p. 83), convey a sense of urgency to act by implementing RII-promoting incentives and funding systems that target universities within the EU.

Other high-profile stakeholders in Europe's higher education sector have also expressed their opinions. The EUA and CESAER issued a series of

general recommendations for regional, national, and European policymakers as part of their views on the future of universities within regional innovation systems (EUA, 2018; CESAER, 2018; Reichert, 2019). Their statements exemplify and amplify the recurring request from the higher education sector, as well as its stakeholders, to develop a dedicated EU stream of sustainable, longer-term funding for innovation activities within universities.

But how to design such policy instruments, especially at the EU level, to deliver an RII agenda for universities in Europe? As a result of historical developments and national governance arrangements, many of these universities enjoy a considerable amount of organisational autonomy. This imposes significant limits on regional, national and European governments or other policymaking actors to influence or steer universities towards regional engagement and RII. However, these universities are also dependent on funding from external sources, which suggests three possible ways for funding-based incentive systems that European, national or regional governments could implement: (1) innovation performance-based funding; (2) innovation performance contracts which make the positive assessment of a strategy for improving RII performance or a particular aspect such as university–business collaboration a condition for funding, and (3) project funding.[1] Each of these three funding instrument types could, in principle, contribute to the policy-driven allocation of additional funding for regional innovation objectives. EU funding could be supplemented by the Member States, if considered useful by national or regional governments. All three could probably rely, in one way or another, on an RII framework for assessment of proposals and the monitoring and evaluation of RII performance.

At present the RII assessment framework is not (yet) implemented at the EU, nor the national or regional level. If policymakers choose to implement it, they can best do it in the form of policy experimentation based on a Theory of Change, as described in section 3.2, underpinning the assumption that RII-oriented inventions at universities may significantly contribute to change in regional innovation systems or interactions between universities and

[1] 'Project funding' refers to funding of a group or an individual to perform an R&D activity limited in scope, budget and time, normally on the basis of the submission of a project proposal describing the research activities to be done (Van Steen, 2012). 'Institutional funding', organisational level funding, is attributed to a research-performing organisation (either a university, another higher education institution or a research organisation), with no direct selection of R&D projects or programmes and for which the organisation has more or less freedom to define the research activities to be performed. Institutional funding can be provided as a block grant or in a competitive manner, e.g. on the basis of *ex post* performance assessments (performance-based funding) or in the form of performance contracts in which a university agrees with a funding body to meet certain agreed upon objectives.

regional partners. Adopting an experimentation mode allows implementation to proceed even if there is still uncertainty about the immediate prospects of a solution or, ultimately, the anticipated positive outcomes. In this particular case, RII-promoting initiatives and incentive systems can act as a 'strategic niche' (Schot and Geels, 2008) where such a system change can occur, learning from the self-appraisal reporting and self-assessment, to create new interactive regimes and associated 'regional science and innovation landscapes'. Such a Theory of Change driven approach is also more amenable to effective implementation, which requires a shared understanding of the problem by all major stakeholders, the existence of an appropriate policy environment and acceptance of the proposed policy solution by decision makers (Flanagan et al., 2011).

Well-designed incentive instruments may help tackle some of the implementation challenges identified in previous chapters of this book, for example to counter-balance the tendency among universities to tell only success stories and downplay their failures or less positive achievements. If properly embedded in a university's organisational framework, such incentives may stimulate universities to also identify what does not work (well enough) and develop ways to address these problems or related future challenges. Acknowledging and analysing failures and obstacles may help to adopt strategies to overcome bottlenecks or shortcomings. RII incentive systems and associated assessment frameworks will then also become organisational self-learning tools that offer opportunities for retrospective and future-oriented enquiry within the university.

In order to develop incentive systems there needs to be a set of design principles in place concerning their technical feasibility and attractiveness for applicants, in which incentives should:

- be tied to clear objectives which can be measured/assessed;
- fit within existing or new legal and regulatory frameworks of the EU, its Member States and/or regional authorities;
- align with existing or new funding structures in the EU 2021–2027 programmes, such as the co-financing arrangements within the European Regional Development Fund (ERDF);
- ensure that the proposed application procedure is as accessible and user-friendly as possible;
- make RII funding arrangements sufficiently attractive for senior operational staff at HEIs (heads of departments, professors, principal investigators, etc.) and/or regional external partners;
- promote and support the development of shared interests and joint activities between HEIs and regional partners;
- enable effective cross-border collaboration and joint activities.

Complying with these principles is probably difficult, if not impossible; trade-offs between feasibility and attractiveness will have to be made.

The next section discusses some potential ways in which the RII assessment framework could be implemented. Exploring the above-mentioned three types to RII funding, sections 10.3 to 10.5 discuss potentially relevant instruments at the EU level.[2]

10.2 POTENTIAL TYPES OF FUNDING INSTRUMENTS

Innovation performance-based funding is understood as the allocation of institutional funding on the basis of *ex post* assessments of innovation performance (Hicks, 2012). At the national level, European governments have implemented a broad range of different types of research performance-based funding systems, some of which have been implemented in ways that connect (research) performance and socio-economic impact of institutional funding allocation (Jonkers and Zacharewicz, 2017).

A high-profile example of such an instrument is the UK Research Excellence Framework in the United Kingdom (UK), where socio-economic impact of research is assessed through expert panels on the basis of case studies of individual research impacts (Derrick, 2018). Other funding instrument types include innovation-related metrics in formulas that are used for allocating institutional resources between universities. Both types of funding systems are not without their critics. The UK system has been criticised for, among other reasons, putting a large burden on universities, academic staff and evaluators (e.g. Martin, 2011; Smith et al., 2020). The extent to which the case studies succeed in capturing significant impacts is also contested. Because socio-economic impacts of research tend to take a long time to develop and are subject to a high degree of chance, only a restricted selection of evidence-rich success stories will be submitted for assessment. Mechanistic funding formulae based on a limited set of imperfect innovation-related indicators on the other hand, may provide perverse incentives while failing to stimulate the promotion

[2] There are other approaches through which the EU can support the development of innovation systems around universities such as InvestEU, the recovery plan and the just transition funds. Given the nature of these instruments, it is considered less likely that they will directly make use of the RII analytical framework. For the same reason we do not cover the important RII funding for addressing societal challenges and industrial competitiveness in Horizon Europe, the Marie Curie Actions or the ERC. This lack of coverage in this book by no means denies their importance in the development of knowledge, capabilities and human capital developments in universities and their regions.

of real improvements in university impact performance. RII performance may simply be too complex to capture in this manner at present.

Jonkers et al. (2018) initially suggested tying an RII assessment framework's 'narrative with numbers' approach to an innovation performance-based funding system, on the assumption it could help overcome at least some of the above-mentioned challenges. University level, indicator-supported, case studies assessed by expert panels could offer, they argued, both a baseline and a yardstick for improvement that could inform the allocation of institutional funding to universities. By making assessments university and region specific and by relying on 'narrative with numbers' it could allow tailored incentives, while overcoming some of the problems inherent in a narrow focus on a limited set of key performance indicators alone.

However, there are practical downsides to tying this kind of assessment framework to an innovation performance-based funding approach. Especially in view of potential funding allocation decisions based on summative *ex post* assessments, universities have a clear incentive to present case studies focused primarily on success stories, presenting their accomplishments in as positive a light as possible. Expert panels would, without considerable additional research of their own (on-site visitations and fact-finding missions), be challenged to critically assess this material. Even following a further improvement of the RII assessment framework, the universities developing such case studies would have little incentive to engage in a critical introspection and self-analysis of the barriers, challenges, reasons for failures and opportunities to improve the potential they have for contributing to their innovation ecosystem.

While an appropriately designed performance-based funding system might overcome some of these practical challenges, there may be other types of instruments that are more suitable to help universities increase their RII potential. Performance contracts are, in contrast to performance-based funding, a type of *ex ante* funding instrument like project funding. Funding is based on bilateral agreements between the funder and the university, which specifies performance targets that the university promises to deliver in the future and the budget that the university will receive in return. In such performance contracts, the university formulates its ambition in consultation with the funding authority – with or without consultation of other stakeholders such as regional authorities, regional industry or civil society actors. A university may be given a financial penalty if objectives or targets are not met (Jongbloed et al., 2018). Innovation performance contracts, between individual universities and their regional or national funders, have the advantage of customisation and contextualisation. Dedicated contracts provide policymakers and funders flexibility to tailor their agreements to the mission, vision and strategy of individual universities, while taking into account the specificities and needs of the regions in which these organisations operate. Such contracts enable

funding that addresses university-specific regional priorities, organisational challenges, resource constraints or performance targets. Performance contracts could be limited to the university's success in achieving specific and agreed quantitative targets. However, by assessing the university on the basis of its success in realising a university-level theory of change, government actors could also incentivise measures, investments and organisational changes that raise the RII potential of their universities.

A number of European countries or regional governments have implemented performance contracts with universities over recent decades, including: Austria, Denmark, Finland, Germany (e.g. North Rhine Westphalia), Ireland, the Netherlands, and Scotland (Jongbloed et al., 2018). In addition to strengthening the strategic dialogue between universities and regional, national and EU policymakers and to promote horizontal collaboration between different actors, such contracts can help improve accountability and transparency by helping to inform policymakers and the general public about the university's performance (Jongbloed et al., 2018; OECD/EU, 2018).

The feasibility of such contracts will depend on political decision-making, while their design and ultimate implementation will have to comply with the legislative and regulatory systems of national higher education sectors as well as align with system governance practices. The chances of success are larger the more the funding scheme is in line with these national system-level parameters, targeted at regional demand for partnering with local universities, and sensitive to the absorptive capacity of those partners.

Project funding, such as in the EU Framework programme or the ERDF, as well as a myriad of national programmes, is currently the prevalent mode of funding research-related RII activities in universities. The currently available types of project funding, that by its nature is uncertain, time-bound, and scope-limited, may be insufficient for supporting strategic initiatives at the university level. Some resource-rich universities that saw RII as a strategic objective resorted to using other organisational resources to allow for sustainable support of such activities (see e.g. Appendix D – Technical University of Turin). Projects would need to be large, long term and flexible enough to allow universities to make major improvements to their organisational performance.

Funding RII-support projects will no doubt remain an important part of the RII-funding instruments employed at the regional, national and European level as targeted smaller projects continue to have substantial potential for improving RII capacities and competences. As discussed in the next section, European policymakers could seek to leverage new and existing regional, national and European RII project funding instruments to enhance the potential success of university-level performance contracts, notably by tying the eligibility for receiving funding from specific instruments to the existence of a performance contract.

The RII assessment model could be used to support funding to any of the three above funding instrument types at the regional, national, or European level. It will be challenging to assemble expert panels who combine the required degree of independence and expertise at the regional and even national level (see section 9.3). The EU Commission, with its experience in designing and running the Framework programme and co-managing the ERDF, could contribute to the creation of a pool of such experts on which regional and national authorities could draw if the framework would be implemented at those levels.

As for the European policy environment, a new multi-annual financial framework has started in 2021 with three elements that could help implement the RII assessment model:

- The ERDF and the Skills for Smart Specialisation specific objective (European Commission, 2018c);
- The Horizon Europe programme for research and innovation (European Commission, 2018d);
- The Erasmus+ programme for education, training, youth and sport (European Commission, 2018e).

The next three sections explore whether and how the ERDF and centrally managed EU programmes, including Horizon Europe and Erasmus+, could be linked to a further elaboration and eventual implementation of the RII analytical framework during the financial period 2021–2027.

10.3 EU FUNDING OPTIONS: EUROPEAN REGIONAL DEVELOPMENT FUND

The European Commission will channel €193 billion[3] in the next planning period (2021–2027) through the ERDF which makes it one of the biggest streams of EC funding. Between 35% and 60% of the ERDF will deal with innovation, digitisation and SME-related activities, under the 'Smarter Europe' Policy Objective. In its funding of innovation-related activities, the ERDF tends to focus on the diffusion and exploitation of existing knowledge and technologies to support the innovation system in those regions within EU Member States where it is most needed. Universities are one of the sources of local knowledge, and sometimes technologies, in such regions. Furthermore,

[3] The €193 billion reflects the political agreement between the Council and the Parliament of 8 December 2020. At the time of writing, this political agreement was still subject to formal approval by the European Parliament and Council. https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_2381.

they can provide highly qualified human resources that allow businesses to adopt new technologies. The need to match investments in research and innovation with related investment in skills has now been recognised as vital for technology diffusion (European Commission, 2017b), which hitherto had been a weakness of the EU funding framework for smart specialisation (Edwards et al., 2017) and indeed by innovation policy as a whole (Borrás and Edquist, 2015). Some regions had already recognised this gap in their smart specialisation strategies and used the European Social Fund or other sources of national funding to make investments in human capital to match their smart specialisation priorities (Campillo et al., 2017; Pinto et al., 2021). However, post 2020 the ERDF will make such investments under the rubric of 'Skills for Smart Specialisation, Entrepreneurship and Industrial Transition'.[4] The ERDF could therefore be relevant for RII-related activities where funding is meant to support regional innovation system development based on smart specialisation strategies (Foray and Goenaga, 2013; Foray, 2014; 2018; 2019). RII funding could help build and expand regional research and innovation capacities, and incentivise entrepreneurial processes in the region.

The ERDF has so far placed much more emphasis on policy interventions targeted at business enterprises, the RII 'demand side', than attempts to directly change the RII behaviour of 'supply side' universities. Higher education is predominantly a national competence where, as mentioned above, national legislation and regulations limit the space for implementing EU policies. However, within the EU's Cohesion Policy, ERDF co-funded Operational Programmes can help create or support firms, across any economic sector, that are likely to benefit from local universities, either in terms of human resources, skills, knowledge transfer or R&D cooperation. If the ERDF expands and strengthens the demand for inputs from universities, especially in the EU's economically lesser developed regions, it will become more important to increase the RII potential and performance of local universities. In doing so it will improve the proper functioning of the regional innovation systems of which they are part, to help facilitate and motivate local firms to innovate (Kempton et al., 2013; Radosevic, 2017). While not its prime target, universities have benefitted from ERDF funds during the past programming period,[5] especially those that played

[4] Smart specialisation is no longer a one-off *ex ante* conditionality but an ongoing 'enabling condition'. It will also have a reinforced weight in the coming Cohesion Policy: smart specialisation will guide investment decisions within a broader policy area than in the past, including: R&I, digitalisation, SMEs support and skills development.

[5] Many universities in the Eastern and Southern EU Member States show a significant increase of academic research publications over the last few years that acknowl-

an active role in developing smart specialisation strategies (Kempton et al., 2013; Edwards et al., 2017).

In contrast to Horizon 2020 and Erasmus+, the ERDF operates under shared management with the Member States. The EC defines the overall framework in terms of objectives and funding allocation. However, it negotiates funding on a Member State level or the within-country regional level (not at the level of projects or individual stakeholders). The Member States define the content and geographical scale of the different 'operational programmes' in line with the Common Provisions Regulation (CPR) (European Commission, 2018c). The EC forms partnership agreements with the competent regional and local authorities and regional/local stakeholder representatives. Articles 12 and 13 of the CPR stipulate that the Member States shall establish a performance framework, in order to monitor, report and evaluate programme performance during its implementation, and contribute to measuring the overall performance of EU Funds. This framework includes output and result indicators linked to the specific ERDF objectives as well as milestones to be achieved by 2024 and 2029. Managing authorities could work with national and regional governments and use performance contracts with universities to help meet certain ERDF milestones.

If the EIT regional funding option, discussed in more detail in the next section, is successful in enhancing regional innovation performance, it may open an ERDF door for implementing RII-related performance contracts between regional actors and universities on concrete ERDF-supported improvements of regional innovation systems. The amount of RII-support funding that can be allocated would need to be established by a fair, equitable, and verifiable calculation method based on statistical data, other objective information or an expert judgement, which would be verified with historical performance data.

The challenge for the 2021–2027 funding period is to improve on the current ERDF/Smart Specialisation funding system, which depending on the economic development level of the region, caps the EU co-financing share between 50% and 75%. While there are some universal mechanisms that can be adopted across the whole of the EU, the effectiveness of incentives is also contingent on national or local circumstances, especially on how universities are funded and regulated within their national higher education system, and the region's industrial structure and governance system.

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edge ERDF support in their funding grant acknowledgements (Tijssen and Van Wijk, 2020).

10.4 EU FUNDING OPTIONS: HORIZON EUROPE AND THE EUROPEAN INSTITUTE OF INNOVATION AND TECHNOLOGY

The EU has directly supported research and innovation over the last four decades with its series of Framework Programmes. Their budget has increased from about €4 billion in the first framework programme to nearly €80 billion in Horizon 2020, which ran until 2021. The successor programme, Horizon Europe, will have a €95.5 billion budget over the 2021–2027 funding period.[6]

The content and approach of the Framework Programme series has evolved over time to include commercial research and innovation as well as academic research. In Horizon 2020, funding for industrial leadership and societal challenges accounted for double the budget of the funding for excellent science. The first pillar of Horizon Europe combines the different actions on excellent science while the second pillar combines industrial innovation and global challenges into one pillar, as exhibited in Figure 10.1.

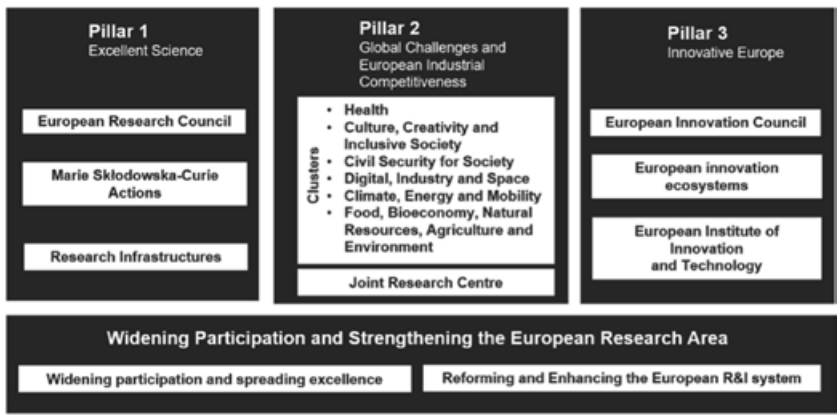

Figure 10.1 Programme structure of Horizon Europe

Horizon Europe allows for putting more emphasis on innovation, through a new pillar on Innovative Europe, which is of crucial relevance to the RII

[6] The €95.5 billion reflects the political agreement between the Council and the Parliament of 10 December 2020. At the time of writing, this political agreement was still subject to formal approval by the European Parliament and Council. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_2345.

assessment framework. With an overall budget of around €13.6 billion,[7] this pillar aims to bring innovation faster to the market, while recognising that innovation is complex and the result of investments at different stages of the development cycle and dependent on dynamic innovation ecosystems.[8]

Part of the third pillar of Horizon Europe aims at "developing an effective innovation ecosystem at EU level, and encouraging cooperation, networking, and the exchange of ideas, funding and skills among national and local innovation ecosystems" (European Commission, 2018b). As a new instrument, its operationalisation will become clearer over time.[9] It provides a policy environment in which an RII analytical framework can be explored and potentially linked to 'experimental' funding. The pillar's 'European Innovation Ecosystem' instrument will have a budget of €527 million[10] and will co-fund joint innovation programmes delivered by national bodies, including those that promote knowledge transfer and university–business cooperation.

Of all programmes within the Horizon Europe funding portfolio, the European Institute of Innovation and Technology (EIT) has perhaps the most potential to make use of the RII analytical framework, since the EIT's strategy is based on the 'Knowledge Triangle' approach, which brings together

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[7] Source: personal contact with DG RTD. The exact figures of this part of the political agreement between the Council and the Parliament of 10 December 2020 had not yet been published at the time of writing. The political agreement was also still subject to formal approval by the European Parliament and the Council.

[8] In September 2020, the European Commission introduced the 'ERA Hubs' initiative, to create regional organisations designed to boost regional research and innovation systems in Europe and provide better access to the results elsewhere within the European Research Area. The exact form which the ERA Hubs may take still need to be announced, but they will be similar in nature of the Digital Innovation Hubs. It could be explored to what extent the RII framework can help inform the analysis or assessment of participating partners in these Hubs.

[9] Being a new funding instrument, its operationalisation and implementation will become clearer over time, a process that will start with a European Innovation Council Forum, bringing together all the EU Member States but also associated Horizon Europe countries, in order to help develop the ecosystem approach. This Forum will discuss innovation-friendly regulation as well as coordination of underpinning national innovation programmes, which could include a discussion on how RII assessment may be linked to institutional funding. Between October 2019 and February 2020, the Commission already organised a series of consultation workshops on this future pillar of Horizon Europe (European Commission, 2020).

[10] Source: personal contact with DG RTD. The exact figures of this part of the political agreement between the Council and the Parliament of 10 December 2020 had not yet been published at the time of writing. The political agreement is also still subject to formal approval by the European Parliament and the Council.

research, education and enterprise.[11] Pending final confirmation of the political agreement between Council and Parliament, the EIT will have a budget of nearly €3 billion under Horizon Europe, representing a 25% or €600 million increase compared to the previous funding period.[12]

The EIT was created in 2008, partly in response to missing the goals of the Lisbon Agenda, which aimed to position the EU within the global knowledge economy. European policymakers wanted to replicate vanguard organisations found elsewhere in the world that facilitate entrepreneurship and the rapid market introduction and development of innovative ideas (Reillon, 2016). In contrast to individual organisations located in just one place, the EIT was operationalised through trans-national Knowledge and Innovation Communities (KICs). These KICs are independent legal entities that enjoy a large degree of autonomy in terms of strategy and choice of activities from the EIT headquarters in Budapest (Hungary). Composed of firms, research centres, higher education institutions as well as cities, regions and NGOs, eight KICs have been launched over the last decade. They fund investments in education, research, and entrepreneurship, which are intended to work together in a triangular mode. While many universities host KIC co-location centres,[13] others take part in activities under the EIT Regional Innovation Scheme, which aims to spread the impact of KICs more widely across Europe in countries and regions that lag behind in terms of innovation performance. At the same time universities have the potential to bring together local stakeholders active in a region's smart specialisation priorities (Edwards et al., 2017) and therefore they are well placed to bring together innovation communities and combine sources of funding (Ozbolat et al., 2019).

While the EIT was created to pursue excellence in the integration of innovation-driven research, entrepreneurial education and entrepreneurship, there has been increasing pressure on KICs to extend their impact beyond the immediate KIC partners, thus stimulating innovation on a wider scale. This is partly the rationale and motivation behind proposals for the EIT to engage in capacity building activities for innovation in HEIs, as part of its Strategic Innovation Agenda from 2021 to 2027 (European Commission, 2019c). While

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[11] The knowledge triangle originated as part of the European Union's Lisbon Strategy (Cervantes, 2017; Soriano and Mulatero, 2010). It is a conceptual framework for analysing and understanding knowledge creation processes that depend on productive interactions between education, research, and innovation. The framework highlights the need for an integrated approach across education, research, and innovation policies.

[12] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_207.

[13] Co-location centres act as nodes that bring together all the main KIC activities in one physical place.

managed by the KICs, a large share of the activities will benefit universities that are not currently KIC partners. This can potentially allow for learning between universities from different parts of Europe, and between those that are more and less developed. According to the Commission proposal, the details of activities under this pilot action will be developed in the first three years, but the Council has suggested the following (Council of the European Union 2020):[14]

- the exchange and implementation of best practices in knowledge triangle integration (including organisational learning, coaching and mentoring);
- the development of action plans on how to address identified needs in areas such as innovation management, start-up creation and development, technology transfer including IPR management, people and organisational management and engagement with (local) stakeholders and civil society;
- the implementation of innovation capacity development action plans and their follow-up.

The same proposal suggests that the 'EIT label', which is currently used within the KICs for quality assurance and marketing of master and PhD degrees, could be extended to those universities involved in capacity-building pilot activities. The label would be particularly useful to build entrepreneurial capacity among students and staff in participating universities, drawing on their recent experience in the KICs.

The EIT–KIC capacity-building action presents a good opportunity to test the RII analytical framework and demonstrate its value for the KICs as well as regional and national authorities. From the KIC perspective, it could be used to improve the regional innovation impact of university partners, which in turn would strengthen other activities within the knowledge triangle. The RII analytical framework is explicitly mentioned in the proposed SIA as a tool that could be used within that action, along with the HEInnovate self-assessment tool (see section 3.1). The RII analytical framework is already used in the co-creation phase of the new initiative to frame the discussions on the categories of activities to be included and on the development of the impact framework for this initiative (inputs, outputs, outcomes, impacts).

Following a further redesign to ensure the framework could guide the development of self-assessments as discussed in Chapter 9, an RII assessment

[14] At the time of publication, the decision on the SIA was still in the process of being adopted by the Council of the European Union and the European Parliament, with many proposed amendments.

framework could be used in a number of ways, but some suggestions to consider are:

- RII self-appraisal could form part of capacity building and training exercises;
- RII assessments could be linked to targeted or increased funding at the strategic level for departments or staff that increase the impact of their university;
- Experts could be contracted to assess the RII of universities not currently members of a KIC;
- Assessments could form part of the process of joining a KIC. Regular RII assessment could form the basis for providing top-up institutional funding to universities in order to improve their RII potential, e.g. through performance contracts.

Policymakers will need to assess the suitability of the RII assessment framework in each of these proposed steps and the most appropriate sequencing and operationalisation.

Using RII assessment within the capacity building action and the mainstream KIC activities could be a mechanism to exploit funding synergies which the KICs have found difficult to explore so far (Ozbolat et al., 2019). This is one of the areas where the links to smart specialisation and the ERDF are underlined in the proposed SIA. KICs could co-finance ERDF investments in the capacity of participating universities to increase their regional impact and guide them in the implementation of ERDF projects aiming at entrepreneurial transformation. This might in the future lead to the adoption of an RII assessment framework within the ERDF. Furthermore, if the framework can help to increase the regional impact of universities involved with the KICs, national authorities may be convinced to use a similar assessment for granting institutional funding within their higher education sector.

10.5 EU FUNDING OPTIONS: ERASMUS PROGRAMME AND THE EUROPEAN UNIVERSITIES INITIATIVE

Erasmus has grown to become a dedicated education programme for the European Union, while respecting national policy competences, although the EU only supports competences for education, training and sport. Focused on promoting learning mobility, which the programme has funded since the 1980s, it now includes support for cooperation and partnerships, notably the flagship initiative on European Universities. The Erasmus+ programme (2014–2020) had a budget of nearly €15 billion with three 'key actions':

learning mobility (key action 1 – 63% of budget); cooperation for innovation and good practice (key action 2 – 28%); Support to Policy Reforms (key action 3 – 4%). The Commission's proposal for Erasmus 2021–2027 retains these three key actions, while nearly doubling the overall budget of the programme to more than €26 billion.[15]

The European Universities initiative was launched in 2017 at the Gothenburg Summit of EU leaders and is intended to help build the European Education Area. This initiative is essentially designed to create trans-national partnerships of universities. The EC hopes that these networks will become sustained alliances, rather than short-term projects that do not outlive the programme funding. While joint curricula and mobility among partnering universities promote the trans-national nature of these alliances, many policy documents underline their role in municipal and regional development, such as in this staff working document:

> [European Universities] should operate on the basis of multidisciplinary approaches, allowing students, lecturers and researchers to co-create and share knowledge and innovation. This could help address the big societal challenges and skills shortages that Europe faces. It could also boost the contribution that higher education institutions make to their regions, in particular through their involvement in the development and implementation of Smart Specialisation Strategies. (European Commission, 2018a, pp. 5–6)

The contribution to regional development and smart specialisation is part of a proposal's relevance that evaluators use in assessing applications for Erasmus+ funding. This is more explicit in some of the alliances than others when looking at the joint long-term strategies they are required to draw up for the proposal. In implementing these strategies, the RII assessment framework could be used by the alliances to assess their contribution to the cities and regions where the partner universities are located. The initiative is linked to Horizon 2020's 'institutional transformation modules', which in 2020 launched pilot calls exclusively for the selected European Universities. This funding, which amounts to €2 million over three years, aims to develop the research and innovation dimension of European Universities through institutional change; it does not support implementation of research and innovation projects as such. Examples of relevant activities include implementing frameworks for assessing the impact of partner organisations within their regional innovation systems. While there are no concrete plans to do so at present, in

[15] https://www.europarl.europa.eu/news/en/press-room/20201207IPR93204/ep-and-eu-ministers-agree-on-erasmus-programme-for-2021-2027. At the time of writing, this agreement still needed to be approved by Parliament as a whole as well as the Council.

the future this initiative may provide an opportunity to link funding to an RII assessment framework.

11. Final reflections

11.1 NEED FOR DEDICATED INCENTIVES

Driven by the current pervasive developments in many European higher education systems, with an increased offering of online courses and travel restrictions imposed on learners, the engagement with local and regional authorities, consumers and employers is likely to become more important. Although the impacts of innovation activities are perhaps less place-bound than those related to teaching and training, the current 'deglobalisation' developments – accelerated by the COVID-19 pandemic – suggest that the business model of the 'research university of the near future' will probably also involve a greater emphasis on local business partners and domestic marketplaces, thus raising the chances of successful RII. In order to improve the RII potential and RII performance of universities, several practical considerations are of paramount importance.

RII self-assessments can allow a university's leadership to identify its strengths, potential, barriers and challenges. Developing a university-specific 'theory of change'-driven action plan can then be an important step in motivating their organisation and stakeholders to increase the university's impact on its regional innovation system. The RII activities could range from a small-scale project with one dedicated regional partner firm to large collaborative programmes stretching across various economic sectors and various public sector partners. The design and implementation of incentive systems need to take into account the complex barriers that may have to be overcome, both internal to the university but also within the wider 'RII enabling' environment.

University leadership and governance structures can be an important 'make or break' factor. In several countries, universities are highly autonomous institutions which can operate relatively independently from local or even national authorities when it comes to setting strategic direction and deciding on specific activities they wish to invest and engage with. Large research-intensive universities in particular may lack a strong central management structure to impose an RII strategy on academic staff, who might fiercely protect their professional autonomy and pursue their own research-driven career trajectories. Such universities will be reluctant, and possibly unable, to (further) align their research, teaching or outreach activities to meet specific short-term regional

demands. Moreover, given the natural resistance within large organisations to major structural change, most universities are unlikely to quickly adapt their priority-setting and resource allocation to meet longer-term RII objectives.

Financial incentive systems can initiate, promote or accelerate organisational change through priority shifts and dedicated action. Dedicated incentive systems would need to be tied to specific objectives and feasible goals. Tailored incentive structures should accommodate different types of activities, institutional backgrounds and regional cooperation arrangements. And RII incentives should be sufficiently amenable to any type of university wishing to apply for RII-targeted support.

Universities should be addressed as an integral part of their geographical locality and their involvement with the regional innovation system. The RII potential of universities is determined in large part by these external conditions, especially in those universities that are located in regions with less developed innovation systems where demand-side actors, such as enterprise associations, tend to be weakly organised stakeholders. These regions may have relatively 'strong' research-active universities that can generate knowledge for national or international users, but will probably fail to help build sufficient absorptive capacity within local SMEs. In these cases, RII incentives should target capacity building activities, or other 'developmental' roles such as shaping regional institutions or supporting local networks that can contribute to smart specialisation strategies. However, the incentives for such activities would need to be tied to specific objectives and targets. Incorporating the 'demand side' in that environment is essential – otherwise RII incentives run the risk of being captured by priorities or interests that are not (sufficiently) linked to regional innovation priorities.

An effective RII incentive system should align with the national funding framework and regional priorities, but also enable a customised approach that is sensitive to institutional circumstances and preferences within universities. Incentives should, ideally, be aligned as much as possible to a university's current RII potential and performance, and its level of RII ambition. However, regional innovation systems are complicated and dynamic entities where changing circumstances, or mere chance, may play a major role in whether or not an individual university can really make a difference in terms of its regional presence and RII. But rather than being held back by such inherent uncertainties or struggling to overcome organisational obstacles, an aspiring university could focus on the opportunities the local environment brings and develop joint initiatives with regional authorities. Grasping such win/win objectives and shared advantages could create the much-needed shift in collective mind-set to create a level of trust and mutual understanding between RII partners, and to achieve a common sense of 'can do' pride in achieving RII goals.

11.2 NEXT STEPS?

It is important to stress that the mixed-methods 'narrative with numbers' RII assessment framework outlined in this book has not (yet) been implemented – neither at regional, national nor supranational (European Union) level. European Commission policymakers may, however, be in a position to effectively harness the power of universities to generate those regional innovation impacts through EU funding instruments.

The RII assessment framework could, for example, be implemented by tying it, through a performance contract, to top-up funding from the EIT's Strategic Innovation Agenda (see section 10.4). Such contracts can be developed in consultation with regional stakeholders and based on an explicit university-level action plan. Formative, forward-looking assessments that underpin such performance contracts may yield better quality RII assessments and a greater potential for improvement in a university's RII performance than summative evaluations tied to performance-based funding. The lessons from this first phase could be taken up, either in an extended development of this EIT instrument or through parallel funding instruments within, for example, the European Regional Development Fund. The potential use of the RII framework for other funding instruments, such as the European Universities initiative, could also be explored.

A comprehensive RII performance management framework – one that comprises operational, analytical and strategic perspectives – could help universities to centralise, harmonise and optimise their RII strategies and practices. To achieve such a framework, universities would need an 'RII process model' that is regularly fed by in-house empirical 'narrative with numbers' information and progress reports. Further guidance, from experts, to interested universities in the development of university assessments is a necessary condition for scaling up the volume of applications of the RII assessment framework. Guidelines for self-assessments can become a toolkit to shape or support organisational learning trajectories within those universities as well as their key regional partners and stakeholders. The European Commission could play a role in setting up a pool of regional innovation experts to help with the assessment panels introduced in sections 9.4 and 10.2.

A lack of systematically collected, comparable RII-related data presents a major challenge for the further development of institute-level RII support mechanisms. By initiating and supporting U-Multirank (see section 2.2), the European Commission has started to promote the development of performance indicators and collection of statistical data on the regional engagement of universities and other higher education institutions, but more work on indicator development and information gathering protocols is urgently needed. The

practical usage of U-Multirank data in EC policy settings offers an incentive for universities to be more involved in the voluntary provision of performance data that underpin U-Multirank's regional engagement indicators, especially those indicators with an insufficient coverage at present.

RII-relevant data on regional higher education systems and regional innovation systems could also help improve the level of collaboration between different actors in regional innovation and alignment of their performance monitoring and associated databases. Co-developing and co-owning RII information management systems (with shared information sources and cooperated databases on RII projects, pathway capacities and performance) could help strengthen regional alliances and sustain mutual understanding between regional partners. It will be a challenging task, where success depends on ensuring sufficient capacity and motivation within universities for effective and sustainable partnerships with regional partners and stakeholders.

A book like this would not be complete without a plea for more studies of RII potential and performance and some final words recommending further development of our RII analytical framework. Collecting high-quality, actionable RII information is obviously a top priority – both with regards to informative and verifiable 'narratives' as well as accurate and meaningful 'numbers'. While the university RII self-appraisal reports, discussed in Part II of this book, provide ample examples of how different types of research universities in Europe have contributed successfully to their local or regional innovation systems, further in-depth assessments are needed to better understand which organisational determinants and external factors are influential in generating positive impacts in their region. These small-scale studies should, ideally, be coupled to larger-scale data gathering in order to contextualise a university's RII profile against the backdrop of general trends and patterns in RII. Further development and testing of qualitative and quantitative indicators, in terms of validity, relevance and options for customisation, is another important line of inquiry where additional effort is needed.

PART IV

Appendices: university self-appraisal reports

Each research-active university has a range of impacts on its local and regional environment. Sometimes the influence is large and becomes front page news, but more often the effects are small and difficult to detect. The scale and scope differs per city, metropolitan area or wider region.

That impact profile depends on many factors and circumstances: on the 'supply' side of the university and the 'demand' side of the universities external stakeholders, users, partners and funders. And the ever-changing interfaces that connect supply and demand.

Each university's 'RII profile', covering both its RII potential and RII performance, is part of a complex dynamic system. It is also an open system because a university's impact doesn't stop at geographical borders.

University RII profiles are unique. Nonetheless, insights can be gained, and lessons learnt, from comparing such profiles.

Five of those RII profiles are captured in a series of self-assessment' narrative with numbers' case studies. These case studies, selected from the 20 universities participating in this project as examples of different types of universities, illustrate how each university engages and interacts with partners and stakeholders in its own city or region. These five accounts present a wide range of activities, the kind of impacts they aim for, and that incentives can make a difference in generating RII. We find both 'good practice' communalities across universities and interesting differences in RII potential and RII performance.

Collectively, these five cases are a testimony of the drive and commitment among European research-active universities to be valuable partners of their local community and regional innovation system, and in doing so being successful contributors to society and the economy.

Appendix A: Guidelines for RII self-appraisal reporting

Several research-active universities participated in a pilot study initiated by the DG Joint Research Centres (JRC). Each university was invited to write a 'narrative with numbers' overview of their university's RII profile, according to guidelines and instructions specified in Box A1.

BOX A.1 GUIDELINES FOR RII CASE STUDY REPORTING

The general contents of each case study should align as much as possible to analytical dimensions of the Regional Innovation Impact Assessment framework available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC109020/jrc109020_iiu27.pdf.

Each case study should consist of the following sections and RIIA-relevant topics:

- Introduction of the university in its local or regional context;
- Regional orientation, strategic development and knowledge infrastructure;
- Education and human capital development;
- Research, technological development and knowledge transfer;
- Enterprise development and entrepreneurship.

It is recommended that each section also discusses the challenges and opportunities that the university faces, contextualised or embedded in the university's vision (or agenda) for the short-term and mid-term future.

Ideally, the case study should comprise a consistent and informative 'narrative', supplemented and strengthened by key managerial indicators and 'performance monitoring' metrics. The supporting quantitative information falls in the following categories: 'regional leadership'; 'human capital development'; 'knowledge generation and transfer'; 'entrepreneurship and enterprise development' in the context of the regional development level. The metrics provided should, where possible, clearly reflect the main trends and evolution in the performance of the university in recent years. In addi-

tion to the quantitative indicators, qualitative evidence of impact pathways would be welcomed.

The case studies should address as many of the following key questions as possible:

- How embedded is the university in the local or regional innovation system?
- How does the university impact on, or co-develop, that system?
- How does the university contribute to diversifying the knowledge portfolio and infrastructure?
- How does the university contribute to the (further) integration into domestic or international R&D communities or networks?
- How does the university contribute to a more vibrant sociocultural environment?
- How does the university contribute to job creation and upgrading the economic structure and performance?
- How does the state legislation and the university regulations enhance or hamper the knowledge transfer process and the entrepreneurial development?
- What are the main challenges that the university faces and what are the ways for overcoming them?

Appendix B: Catholic University of Leuven[1]

Wim Fyen (KU Leuven Research & Development), Stijn Kelchtermans (Faculty of Business and Economics, KU Leuven) and Milena Slavcheva (European Commission, Joint Research Centre)

B.1 INTRODUCTION OF THE UNIVERSITY AND ITS REGIONAL CONTEXT

The Catholic University of Leuven ('Katholieke University Leuven' in Dutch, abbreviated here to 'KU Leuven') is located in Flanders, which is the northern part of Belgium and home to about 6.5 million inhabitants, more than half of the country's 11.4 million population.[2] It is an innovative and prosperous region in a country whose GDP per capita rose to €38 500 in 2017 compared to €30 000 for the EU28 average.[3]

It should be noted that in the early 1990s, political decisions in Belgium moved the centre of gravity of science and innovation policy from the federal to the community and regional level. For KU Leuven this means that all innovation and education policies are made by Flanders, classified as an innovation leader, while Belgium as a whole is classified as a strong innovator.[4] The total R&D intensity in Belgium and Flanders respectively reached 2.49% and 2.70% of GDP in 2016, narrowing the gap with the Europe 2020 target of 3% and being above the EU28 average of 1.94%. The government input for R&D in Flanders is above the EU28 average (GBARD as % of GDP): 0.67% versus

[1] The (re-)numbering of sections, tables and graphs in this appendix was done by this book's editors, as well as other minor edits to ensure text and format consistency across all appendices B to F.

[2] https://statbel.fgov.be/nl/themas/bevolking.

[3] https://ec.europa.eu/eurostat/web/products-datasets/-/sdg_08_10.

[4] European Innovation Scoreboard at https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en.

0.64% in 2016, and rising further to 0.75% in 2017.[5] Belgium also has a relatively highly educated population: 44.3% of 25–34-year-olds had completed tertiary education (ISCED 5–8) in 2016, compared to 38.2% in the EU28. The country has an excellent science base: 12.6% of the country's scientific publications were among the top 10% most cited publications worldwide in 2014 (compared to the EU28 average of 11.08%). In terms of technological performance, Flanders occupied ninth position in terms of the number of European Patent Office patent applications per million inhabitants in 2012 compared to a reference group of countries that jointly account for 95% of global patenting activity.[6] Fifty-seven per cent of Flemish companies were 'innovative' in the period 2012–2014 according to the Eurostat definition.

KU Leuven was founded in 1425 and is one of the oldest research active universities in Europe. In 2017, it had about 57 000 registered students (of which 17% are international), which makes it the largest in Belgium. It has about 12 000 staff members complemented by some additional 8 000 full time equivalent staff in the university hospital. It is a comprehensive, research intensive university encompassing 16 faculties that are organised in three groups: Science & Technology, Biomedical Sciences, and Humanities & Social Sciences.

KU Leuven forms a network with five university colleges across Flanders and Brussels in the 'KU Leuven Association'. This Association was founded in 2002 in response to the Bologna Declaration of 1999, which sought to increase synchronisation of higher education systems in Europe. Its university colleges account for some additional 50 000 students distributed over 21 campuses. In total the KU Leuven Association represents about 42% of the total Flemish student population. Its members exchange expertise and pool resources, with the aim of improving the quality of teaching and research.

As reported in more detail in section B.4, KU Leuven is not only an important contributor to Belgium's scientific performance as far as the quantity of scientific output is concerned, but it also excels in terms of quality. In line with the innovative performance in the business sector, KU Leuven was named Europe's most innovative university based on the Reuters ranking of 2016, 2017 and 2018. As the highest-ranked Belgian university, KU Leuven has been ranked 48th in the Times Higher Education ranking 2019, and has been consistently among the top 50 research active universities in the world over recent years.

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[5] Vlaamse Speurgids, 2018 at //www.vlaanderen.be/publicaties/speurgids-ondernemen-innoveren-2018-het-vlaamse-overheidsbudget-voor-economie-wetenschap-innovati.

[6] Vlaams Indicatorenboek, 2018 at https://www.ecoom.be/assets/232.

B.2 REGIONAL ORIENTATION, STRATEGIC DEVELOPMENT, AND KNOWLEDGE INFRASTRUCTURE

KU Leuven has forged strategic partnerships with many actors in the Flanders region, as well as worldwide, yielding collaborations at various levels, from the local and regional to the national and international.

Locally, the university regularly consults with its stakeholders, such as the Leuven-based nanoelectronics centre (IMEC[7]) and the city council members of its hometown, the city of Leuven. This regular consultation led to the creation of Leuven.inc[8] in 1999, which was consolidated in 2016 through the establishment of the 'Leuven Mindgate'[9] initiative to promote the city's regional branding. KU Leuven has also built strong ties with several other cities including Genk and Kortrijk, allowing the university to extend its network of science parks and incubators. There are also very intense collaborations within Flanders in order to promote the region as a knowledge hub towards foreign companies, via an initiative called 'Flanders Smart Hub'.[10] Setting up networks like these helps speed up the 'Brownian motion' process that results in serendipitous connections, as other successful university-based clusters – such as the one in Cambridge[11] – have demonstrated.

At the Flemish government level, the university collaborates with most agencies relevant for science and innovation support and policy, such as Flanders Innovation & Entrepreneurship (VLAIO), Science Foundation Flanders (FWO), the Department of Economy, Science and Innovation (EWI), Flanders Investment and Trade (FIT) and the regionally embedded government innovation centres.

Within the broader region, KU Leuven is actively involved in cross-border collaborations, such as ELAt, a network linking the knowledge regions of Eindhoven, Leuven and Aachen, forming an advanced technological Euroregion.

At the European level, several KU Leuven research centres collaborate with Flemish spearhead clusters – large-scale Triple Helix initiatives addressing strategic domains which receive public support for ten years – and internationally prominent research groups.

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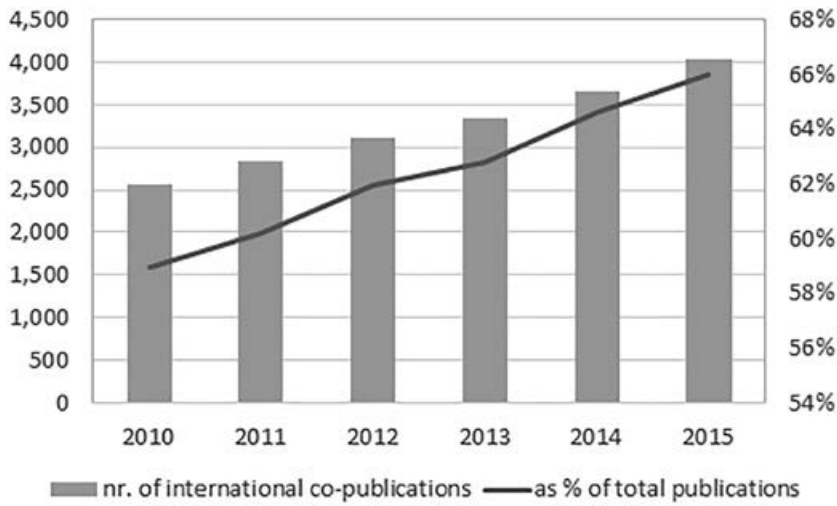
7 https://www.imec-int.com/en/home.
8 https://www.leuveninc.com/.
9 https://www.leuvenmindgate.be/.
10 https://www.smarthubvlaamsbrabant.be/international/.
11 http://www.cambridgephenomenon.com/.

Scientifically, KU Leuven plays a key role in connecting the regional innovation system to international networks. To illustrate, as shown in Figure B.1, the number of scientific publications with international co-authors has increased from about 2 500 in 2010 to 4 000 in 2015 (+60%) and these international co-publications account for a growing share of the university's scientific output, reaching two-thirds in 2015.



Note: The number of international co-publications counts those KU Leuven publications with at least one other country (besides Belgium) among the affiliations of the co-authors. The curved line indicates the number of international co-publications of KU Leuven divided by its total number of Web of Science publications (of the types Article, Note, Letter or Review) in the respective year.
Source: InCites Dataset (data exported 11 July 2018).

Figure B.1 Scientific publications with international co-authors

At the institutional level, KU Leuven is actively engaged in several international networks, such as the Health Axis Europe,[12] a strategic alliance with the biomedical clusters in Heidelberg (Germany), Maastricht (Netherlands) and Copenhagen (Denmark). KU Leuven also actively participates in professional associations on knowledge transfer such as Proton-ASTP[13] and AUTM.[14] The

[12] https://www.health-axis.eu/.
[13] https://www.astp-proton.eu/.
[14] https://autm.net/.

university is a founding member of academic networks such as CESAER[15] and LERU[16] which serve not only as meeting places to exchange best practices among peers, but also as places to engage in policymaking at the EU level.

KU Leuven is a very active participant in the Knowledge and Innovation Communities (KIC), which are partnerships of businesses, research centres and universities established by the European Institute of Innovation and Technology (EIT) via a competitive application procedure. KU Leuven has typically contributed to these KICs through clusters around its research activities. As an example, KU Leuven Materials Research Centre (LMRC,[17] an interdisciplinary initiative on materials research) has since 2015 taken an active role in the KIC Raw Materials, while the Leuven Medical Technology Centre (LMTC,[18] combining engineering sciences and biomedical sciences) was from the start actively involved in the KIC Health. The same goes for KU Leuven's initiative in clustering Flemish energy-related research into the joint research centre Energyville,[19] which has taken a leading role in the KIC InnoEnergy and for the KU Leuven Food and Nutrition Research Centre (LFoRCe[20]) which is actively involved in the FoodConnects consortium that was selected by the EIT to manage KIC Food.

B.3 EDUCATION AND HUMAN RESOURCES DEVELOPMENT

One of the strategic objectives of the university's technology transfer office is to deepen and support a culture of innovation and entrepreneurship. This is evidenced by a variety of voluntary training initiatives that help to instil an entrepreneurial mind-set among staff, such as a residential three day master class in entrepreneurship[21] and a modular five day training programme on research valorisation for doctoral and post-doctoral researchers.[22]

Internationalisation is also an important part of the university's human resources development policy. For instance, foreign experience is taken into account in hiring and tenure decisions for new faculty members.

In 2016, KU Leuven set up a Student Career Centre (SCC) which acts as a one-stop shop for all career- and employment-related matters for its students.

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15 https://www.cesaer.org/.
16 https://www.leru.org/.
17 https://set.kuleuven.be/mrc.
18 https://set.kuleuven.be/lmtc.
19 https://www.energyville.be/en.
20 http://www.lforce.kuleuven.be/.
21 See the ELAt example in section B.2.
22 See also: https://lrd.kuleuven.be/events/doctoral-school-training-course.

Being the largest university in Belgium, KU Leuven has a profound impact on regional employment. A survey[23] amongst its recent master students held in 2014–2015 indicates that 83% find a job in less than three months and more than 98% in 12 months. About half (51%) of the recent graduates are employed in the private sector, 32% in government and 13% in the health/welfare/socio-cultural sectors.

Within the SCC, the Leuven Community for Innovation driven Entrepreneurship (Lcie, addressed in detail in section B.3) has responsibility for all entrepreneurship-related matters. When it comes to bringing entrepreneurship within the educational system, a variety of programmes have been implemented:

- A first set of activities deals with improving entrepreneurial skills: over recent years, various KU Leuven faculties have introduced courses on entrepreneurship both in the master- and bachelor-level curriculum. A portfolio of entrepreneurship courses based on these new courses is managed by the Lcie Academy – an interdisciplinary working group of professors lecturing in entrepreneurship – providing a certificate of entrepreneurship for students participating in the Lcie Academy. The portfolio is created such that students are required to take a variety of courses from different faculties, thereby promoting interdisciplinarity as one of the core values of innovation-driven entrepreneurship. Next to the Lcie Academy courses, other tracks, including a postgraduate entrepreneurial degree for engineering students as well as a Major in Entrepreneurship for business students was established. In the 2017–2018 academic year, more than 1 000 students participated in one or more of the Lcie Academy courses, in the postgraduate degree for engineers and/or in the Entrepreneurship Major (equalling some 1.75% of all registered students).
- A second set of activities focuses on how to leverage initiatives that originate within the Lcie community. These new initiatives often start as an extracurricular activity, but when successful, they may find their way into the official curriculum for certain study programmes. In such cases, the Lcie Core team assists in this transition process. A first example is the course 'Product Innovation Project' (PiP[24]) that was created by a group of students. It is based on a project-based learning format, whereby a multidisciplinary team of students develops a solution to a given problem, delivering a prototype and business case. The concept found its inspiration from

[23] https://www.kuleuven.be/onderwijs/onderwijskwaliteit/bevragingen/alumnibevraging.

[24] http://pipleuven.lcie.be/en/.

similar initiatives developed at Aalto University[25] and Graz University of Technology[26] and was started at KU Leuven with three faculties that offered this course to their students. After four years of operation, the concept has been accepted in 14 (out of a total of 16) faculties. Noteworthy is the support from the faculties in bringing this format into the curriculum. For example, the faculty of engineering science has created a new course descriptor for PiP, that allows students to fully embed this project in their curriculum. This approach is now followed by several other faculties, demonstrating how bottom-up initiatives can become drivers of curricular change.

- In addition, several initiatives were developed by the student and academic community providing valuable support for entrepreneurial projects. A noteworthy example is IusStart, which is a legal clinic initiated in 2014 by PhD students from the faculty of Law, whereby students provide legal advice for start-ups. At present, the concept has been fully incorporated by the faculty of Law in the form of a master's thesis for law students. Every academic year, some 10–20 IusStart law students provide (as part of their master's thesis) legal advice to some 5–10 start-ups supervised by several PhD students and a number of law offices. Along similar lines, the 'TechStart' concept was initiated recently by PhD students from the engineering faculty, whereby engineering students provide technology advice to start-ups, thereby receiving ECTS credits.

B.4 RESEARCH, TECHNOLOGICAL DEVELOPMENT, AND KNOWLEDGE TRANSFER

In 2018, KU Leuven registered €1 002 million of revenues and €953 million of expenditures. Research expenditures accounted for €476 million, comparable to the expenditures of 2017.[27]

Research excellence is illustrated by the number of Web of Science publications (co-)authored by KU Leuven researchers, which has been increasing steadily over recent years, amounting to 6 102 in 2015 (Incites data).[28] Over

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[25] http://pdp.fi/.

[26] http://product-innovation.at/.

[27] KU Leuven, 2018 annual report.

[28] If both the Web of Science (SCIE, SSCI, AHCI, Proceedings) and Flanders' Academic Bibliographic Database for the Social Sciences and the Humanities are taken into account, scientific output rose to about 8 800 peer-reviewed publications in 2014–2015. These publications comprise journal articles, monographs, book chapters and conference proceedings (KU Leuven, 2017 annual report).

the 2007–2016 period, KU Leuven published 47 742 publications in the WoS database's SCI index, which attracted 901 262 citations (accounting for 42.9% of all citations received by scientific publications in Flanders). Over the same time period, 6 269 papers were published in the social sciences and humanities (SSCI and A&HCI citation indexes in the Web of Science database), attracting 39 741 citations in the SSCI-index, or 43.7% of all SSCI-citations in Flanders. About 3% of the university's publications are in the highly selective top 1% of the worldwide citation distribution and its normalised citation impact indicator was 1.7 in 2015, showing that the university's international impact is clearly above average.[29]

Furthermore, KU Leuven awarded 802 doctoral degrees in 2016–2017, of which 44% were awarded to non-Belgian researchers. The university also performs among the very best at European level, with 107 ERC[30] Grantees (including affiliates with VIB[31] and Imec and incoming ERC-grantees) of which 55 were Starting Grants. KU Leuven participated in over 540 projects in the 7th Framework programme (2007–2013), ranking sixth in the league of higher education institutions. In Horizon 2020, KU Leuven maintains its sixth position with regard to participation, having had 260 projects approved, worth €145.9 million. The university also attracts international research talent: in 2017, 33 of the 89 newly hired professors (37%) were non-Belgians.

KU Leuven Research & Development (LRD) was established in 1972 as one of the first technology transfer offices in Europe with a mission to support the university staff in all aspects of research exploitation. Starting from the excellent science base at KU Leuven, LRD has developed a solid tradition of collaborating with industry, securing and licensing intellectual property rights, and creating spin-off companies. The support is given by a multidisciplinary team of over 100 experts who guide researchers in their interactions with industry and society, and help them to best leverage the societal and economic potential of their research. LRD is set up as a separate business unit within the university and plays a constructive role in the development of innovation policy in Flanders as well as in Europe. It actively collaborates with the government, amongst others with respect to the new cluster policy of the Flemish government, the grand challenges, smart specialisation, Horizon 2020 and the other European policy instruments.

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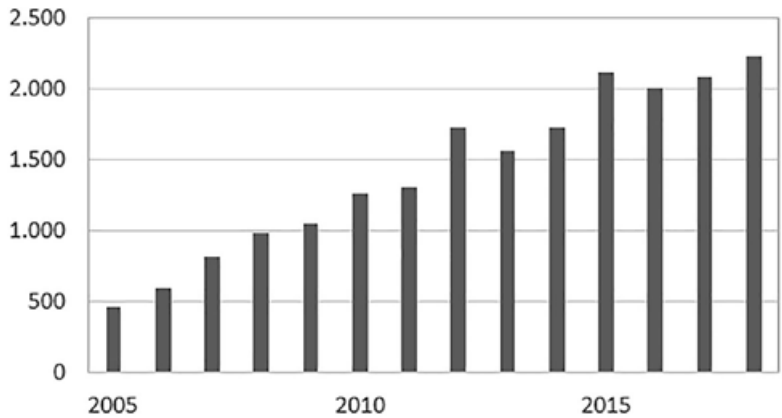
[29] A normalised citation impact score of 1 equals world average in the respective field of science; KUL is 70% above world average (data source: InCites Dataset in 2015).

[30] European Research Council (http://erc.europa.eu/).

[31] Vlaams Instituut voor Biotechnologie, Flemish Biotech Institute (http://www.vib.be/en/Pages/default.aspx).

A first important role of LRD is to manage all research collaboration agreements between the KU Leuven Association and industry, varying from small consulting assignments commissioned by a company to long-term research projects. Figure B.2 shows the number of new agreements (excluding Material Transfer Agreements and Non-Disclosure Agreements) that are drafted by LRD every year. It is evident from the figure that these activities have significantly increased over the last decade and have not been influenced in a major way by the financial-economic crises.



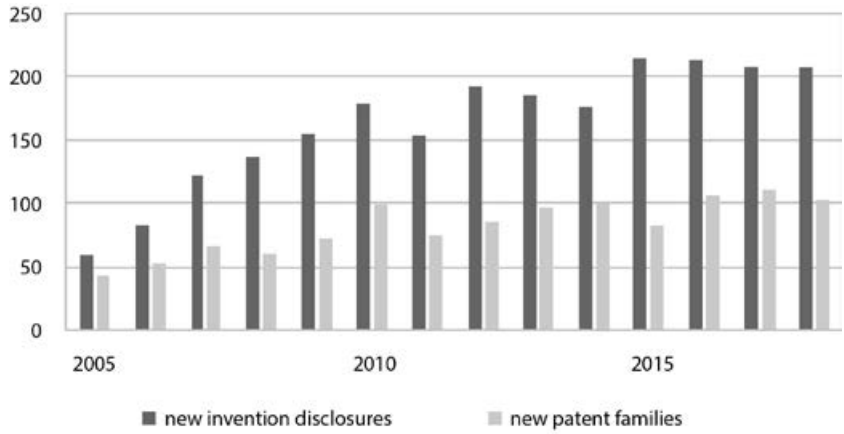
Note: Excluding Material Transfer Agreements and Non-Disclosure Agreements that are being drafted by the university technology transfer office.
Source: Annual reports KU Leuven.

Figure B.2 Yearly number of new agreements

LRD's second activity is the commercialisation of the intellectual property of the KU Leuven Association, which requires an appropriate transfer strategy to ensure that innovation from research at KU Leuven finds its way into society. Figure B.3 shows the number of reported inventions ('new invention disclosures') as well as the resulting number of patent applications at the patent family level.[32] LRD has an active policy of licensing its intellectual property. In 2017, a total of 56 new licences on KU Leuven intellectual property were signed. This amount is comparable to licensing results from previous years

[32] To avoid an inflated measure of patenting activity, the figure reports patent families rather than individual patents as some cases may warrant multiple patent applications for the protection of a single invention.

and includes licences and transfers on patents, patent applications and other intellectual property such as software, designs, and databases. Besides these two main activities, LRD also actively supports the start of new ventures (spin-offs) and the creation of science parks. Both items are discussed in more detail in section B.5.



Source: LRD brochure 2018.

Figure B.3 *Number of new invention disclosures as well as the resulting number of patent applications at the patent family level*

Flemish legislation stipulates that in case of exploitation of an invention the inventors are entitled to a fair share of the proceeds. This provides the possibility to create strong incentives for inventors to collaborate actively with LRD. For that reason, a flexible mechanism to manage these incentives was set up in the form of 'divisions'. The academics responsible for these divisions can invest the money they earn within the divisions, for example for hiring staff, for setting up a patent portfolio or for investing in spin-off companies. Since these investments are made with proceeds from other valorisation activities, academics tend to manage their operations carefully and allocate their resources efficiently. Some divisions act as expertise centres, which take on the role of bridging the gap between scientific work and commercialisation via consultancy activities. This creates a cohort of people with the appropriate skill set to advise businesses and, potentially, set up their own ventures.

The system of 'divisions' at KU Leuven is managed separately from the organisational structure of the university. They act as virtual, often inter-

disciplinary, companies within the university and are maintained by LRD, independently from the central administration. This activity has reached a sizable scale with about 80 such divisions having been set up. Examples are INCENTIM (International Centre for Research on Entrepreneurship, Technology and Innovation Management), Rega Institute for medical research,[33] PMA (Production engineering, Machine design and Automation), MICAS (Micro Electronics and Sensors), COSIC (Computer Security and Industrial Cryptography) and DistriNet (distributed systems).

One of LRD's main operational objectives is to create financial leverage effects in order to support and further develop external funding that can complement within-university financing. Besides Flemish and federal funding, these efforts also explicitly target international funding sources and have contributed to KU Leuven's sixth position in the ranking of Horizon 2020 funding recipients, its participation in four KICs (see section B.2) and in international programmes of institutions like the United States National Institutes of Health (NIH), the Wellcome Trust, and the Michael J Fox Foundation. By accessing these international funding channels, the university and the Flemish research and innovation system as a whole becomes further embedded in international R&D networks, which opens up new paths for research valorisation. In addition to the government and non-profit-related funding streams, KU Leuven is actively involved in setting up bilateral partnerships with the private sector which also adds significantly to this leverage effect. The total revenue of all valorisation activities supported by LRD increased to about €210 million in 2018,[34] roughly a threefold increase since 2005. Part of this revenue is used by academics to hire suitable R&D and support staff to sustain the valorisation activities. This is illustrated in Figure B.4, which shows that in 2018 more than 2 500 employees were paid from the revenues[35] of valorisation activities alone, being a fourfold increase since 2005.

The university has also set up several platforms that bring researchers and business practitioners together on certain themes such as materials science (LMRC), medical technology (LMTC), food and nutrition (LFoRCe), and drug discovery (CD3[36]).

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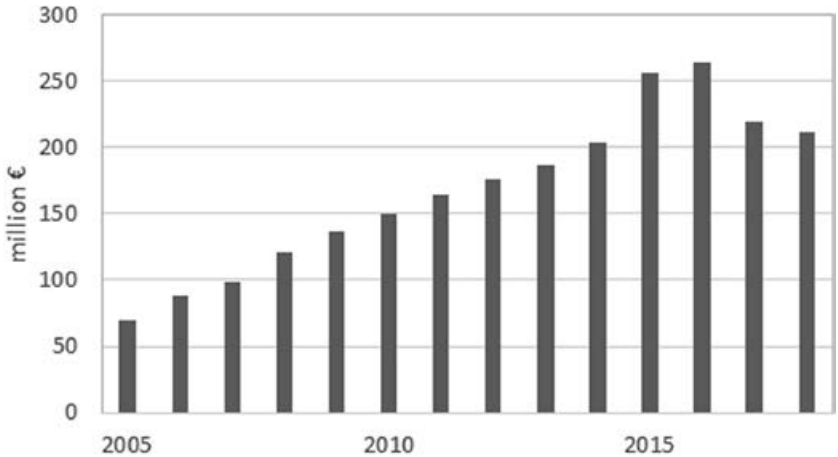
[33] Named after the 18th-century philanthropist and professor Josephus Rega.

[34] There is a decrease in revenue starting in 2017 as a result of a reduction in licensing revenues due to the expiration of the patent on Tenofovir, a drug that has been commercialised in collaboration with Gilead Sciences.

[35] The decrease in revenue in 2017 is largely related to a reduction in licensing revenues due to the expiration of the patent on Tenofovir, a drug that has been commercialised in collaboration with Gilead Sciences.

[36] Centre for Drug Design and Discovery (http://www.cd3.eu/).



Source: Annual reports KU Leuven.

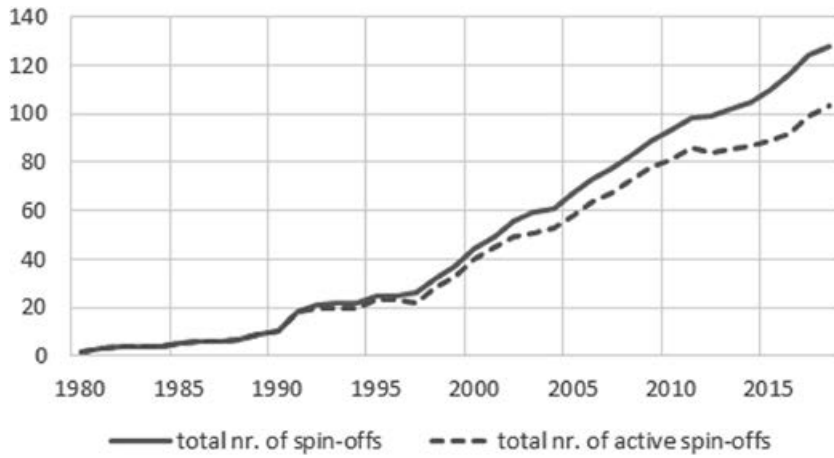
Figure B.4 Yearly total revenue of all valorisation activities supported by LRD

B.5 ENTERPRISE DEVELOPMENT AND ENTREPRENEURSHIP

The support for venture creation at KU Leuven is based on a combination of decentralised attention towards entrepreneurship combined with a strong central support system. As indicated in the next section, a variety of funding schemes exist for researchers to bring their research closer to the market. In addition, the central support for and communication about impact that is reached with valorisation activities lowers the perceived barrier for entrepreneurial behaviour with researchers willing to engage in entrepreneurship. In the period 1979–2017, 124 spin-off companies were founded, of which 99 were still active at the end of 2017, as illustrated in Figure B.5.

One of the key success factors of KU Leuven's enterprise development activities is the availability of complementary incubation funding instruments. They allow researchers to move up their research on the Technology Readiness Level (TLR) scale in order to bring it to a marketable product or service. The most important instruments are:

- The Industrial Research Fund (IOF), set up by the Flemish Government in 2004 in order to 'bridge the gap' between research and application. The fund serves all five universities in the Flemish community and has increased from €10 million in 2005 to about €32 million in 2018 and



Notes: KU Leuven (solid line) and total number of spin-offs that are still active (dashed line). A spin-off is a legal entity of which the university has become a shareholder as a result of a contribution of its intellectual property (licence of transfer). Besides spin-off companies, several other entities are created with a link to the university, but these are not counted as spin-offs.
Source: LRD brochure 2018.

Figure B.5 Total number of spin-offs

a further large increase of €20 million in 2019. These funds are distributed over the Flemish universities and their associated university colleges according to a set of measurable performance indicators, including industrial contracts, EU projects, patents, and spin-offs. Based on these parameters, the share of KU Leuven in the overall IOF funding amounts to 46%, totalling about €15 million in 2018. This is used for two types of funding schemes: mandates (i.e. the funding of research managers that are structurally embedded in a research group) and competitive project-based funding. KU Leuven currently has about 35 such 'IOF research managers' and starts some 30 valorisation-oriented projects each year.

- The Gemma Frisius Fund (GFF) is a seed capital fund that was established in 1997 as a joint venture between KU Leuven and the banks KBC and BNP Paribas Fortis. The objective of the fund is to stimulate the creation and growth of KU Leuven spin-off companies. Over the years, the GFF has invested in 51 KU Leuven spin-off companies and since 2009 it operates as an evergreen fund. Noteworthy is also that in the period 2005–2018, KU Leuven, including its venture capital fund (GFF), invested €38.5 million in its spin-offs, while third-party investors matched this with €1 054 million, generating a leverage effect of about 30:1.

- The Centre for Drug Design and Discovery (CD3) brings expert drug discovery capabilities and financial means to academic research groups and small companies in order to translate innovative research into promising drug discovery programmes that are well qualified for further development by pharma or biotech companies or by setting up a spin-off company. Supported by LRD and the European Investment Fund, CD3 launched a €60 million fund in 2016.
- Over recent years KU Leuven has also set up an elaborate set of partnerships and participations as a co-investor in a variety of venture capital funds in domains that are relevant for its activities, such as life sciences, advanced manufacturing, chemistry, materials, and ICT. This allows to further support the growth of the Leuven ecosystem in general and more specifically of its portfolio of spin-off companies.

While so far most emphasis on spin-off creation has been on academic research-based ventures, many universities have also started to focus on student-led ventures.[37] Along these lines, KU Leuven launched Lcie, the Leuven Community for Innovation driven Entrepreneurship, in 2014 (see also section B.2). It is largely managed bottom-up with significant student involvement throughout its governance system and supported by a small team that is embedded within the TTO, ensuring the necessary autonomy to operate.

In its first years of operation, Lcie has evolved into a university-wide 'brand' for student entrepreneurship with a diverse set of stakeholders. It is financed through a mix of funding sources and was jump-started with small structural funding from the TTO (including in-kind support via a part-time coordinator) and a yearly allowance of the local network of entrepreneurial start-ups (Leuven.inc, see section B.2). The funding base gradually increased thanks to support from the local government for the student incubator activities, which was followed by support from private sources. Currently, the annual budget is around €200 000 (excluding in-kind 'staff time' contributions) and is set to increase in the future.

Besides access to its research base and incubation funding, the university also provides significant support to its entrepreneurial projects via access to infrastructure and networks. Especially for student-led ventures, one of the most valued support instruments is access to facilities such as meeting rooms and workplaces. It was decided to provide facilities for student-entrepreneurs in a decentralised way, across the various campuses. The facilities include

[37] See e.g. the LERU paper 'Student entrepreneurship at research-intensive universities: From a peripheral activity towards a new mainstream' (https://www.leru.org/publications/student-entrepreneurship-at-research-intensive-universities-from-a-peripheral-activity-towards-a-new-mainstream).

a so-called 'fab lab', providing students with the necessary prototyping tools. In addition, students interested in entrepreneurship get access to a creativity lab where they can meet and work on their business plan. Furthermore, students intending to start an entrepreneurial venture can get office space at an incubator facility that is shared with young start-up companies so that they can come into contact with peer entrepreneurs.

In order to support the further growth of its spin-offs and to leverage the entrepreneurial ecosystem, KU Leuven has also invested substantially in its own science parks, business centres and incubators since the mid-1990s. This resulted in the so-called Leuven Technology Corridor[38] consisting of science parks at several locations both in the immediate vicinity of Leuven (cities of Termunck, Arenberg and Haasrode) and further afield (Genk, Tienen).

The KU Leuven science parks play an important role in attracting foreign investments as well as research capabilities. Noteworthy examples are Huawei,[39] which established its European Research Institute in Leuven in 2015, and the Japanese multinational Nitto Denko Corporation[40] which moved the location of its European Headquarters to Leuven in 2016, both citing the talent pool in the vicinity of the university as a key factor in their decision.

Internationalisation is also an important aspect of the university's policy. In that respect, initiatives have been taken to support the internationalisation process of new ventures that originate from the Leuven ecosystem. Especially relevant for entrepreneurial projects is the fact that the university is a founding member of the BelCham[41] incubators in New York and San Francisco.[42] In this way, KU Leuven-based projects have direct access to the US market and get local support from the Belcham staff.

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[38] https://lrd.kuleuven.be/en/hitech/science-parks-and-business-centres.

[39] https://china.diplomatie.belgium.be/fr/actualites/huawei-announces-launch-its-european-research-institute-eri-leuven.

[40] https://www.leuveninc.com/event/36/4939/Japanse_multinational_Nitto_Denko_Corporation_vestigt_haar_Europees_hoof/.

[41] https://www.belcham.org/atelier/ – the Belgian-American Chamber of Commerce is a not-for-profit organisation with the purpose of supporting Belgian excellence in the United States.

[42] The Belgian-American Chamber of Commerce, is a not-for-profit organisation with the purpose of supporting Belgian excellence in the United States.

B.6 VISION AND STRATEGY FOR THE NEAR FUTURE

In 2018, KU Leuven presented its new strategic plan, based on the following five pillars:

- Truly International – the transition from a national university with a global reputation to a truly international university;
- Future-oriented education – the choice for a future-oriented teaching model based on activation and a corresponding structure of the academic year;
- Going digital – the use of educational technology in a way that facilitates collaborative learning and multi-campus education, and broadens the international reach;
- Interdisciplinarity – the development of an interdisciplinary dialogue in addition to disciplinary depth in education, research and public outreach;
- Sustainability – the choice for sustainable management and a commitment to the Sustainable Development Goals in research and education.

A distinctive aspect of the strategic plan is that the five pillars purposefully do not fit within a single policy domain but each of them impacts multiple aspects of the university. Besides the attention it receives in the new strategic plan, interdisciplinarity has been a common theme in the university's governance in the past, as highlighted by, for example, the research centres and LRD divisions, the governance of student entrepreneurship (e.g. the PiP projects, the composition of the Lcie Academy steering committee) and incubation instruments like CD3. Nevertheless, interdisciplinary initiatives and platforms at the university are considered to be still too limited in number and not visible enough, hence the strategic plan aims to further advance interdisciplinary dialogue in the three missions of the university. In that respect, the university envisages to recognise large-scale interdisciplinary platforms as 'institutes', to provide their work on long-term goals and their approach with a more distinctive profile. Examples are the aforementioned Leuven Brain Institute and the Leuven Cancer Institute.[43] Besides fostering scientific interaction as such, interdisciplinarity is also crucial for establishing serendipitous connections of a more entrepreneurial nature across domains. In this sense, the increased support for interdisciplinarity complements existing networking initiatives like Leuven Mindgate (section B.2).

Another governance principle that will continue to guide KU Leuven is the decentralisation of decision-making, coupled with centralised support

[43] https://www.uzleuven-kuleuven.be/lki/en.

mechanisms. The LRD research divisions discussed in section B.4 are set up by researchers as autonomous vehicles for their technology transfer activities but receive professional support from the university's centralised TTO services. As another example of how decentralised incentives are coupled with efficiency-enhancing centralisation, the Leuven Community for Innovation driven Entrepreneurship coordinates the various entrepreneurship initiatives but is at its heart a student-driven and student-owned initiative.

Also in the future KU Leuven will continue to develop and grow novel platforms and instruments that can further support and enhance the translation of research results into products and services for societal benefit.

Appendix C: Aalborg University[1]

Anne Pors Eriksen, Morten Dahlgaard and Charlotte Pedersen Jacobsen (Aalborg University, Denmark)

C.1 INTRODUCTION OF THE UNIVERSITY AND ITS REGIONAL CONTEXT

At Aalborg University, we are firmly committed to our strategy 'Knowledge for the World'. We have a long history of building strong bonds to our local community but, at the same time, we aspire to have an impact on the entire world through the highest level of education, research, and engagement in partnerships with regional, national, and international partners. It is not without reason that we define ourselves as being a regional, national, and international university.

Despite our international mind-set, Aalborg University's roots in the region of North Denmark run deep, and we are continuously committed to developing our engagement and collaboration with the regional stakeholders, regional businesses, the region itself, and the public institutions. Our values and ways of collaborating reflect that regional commitment, but we also continue to develop those values and ways of driving both innovation and collaboration forward, by which we raise them to the highest international level. With a population of 587 335 people distributed over its 7 879 square kilometres, North Denmark is a small region. It is a low densely populated area and has a lower than average GDP per capita with a growth from 2010 to 2014 in North Denmark at 1.59% compared to 1.63% on a national level. The region has a higher employment share in manufacturing and agriculture compared to the national level.

[1] The (re-)numbering of sections, tables and graphs in this appendix was done by the book editors, as well as other minor edits to ensure text and format consistency across all appendices B to F.

Born out of a merger of established educational institutions and ambitious political forces, the first vision for Aalborg University was to create a strong education centre. Since its establishment in 1974, the university has not only developed an excellent educational programme but also a strong research profile and as of 2018 is ranked in the top 2% of the world's 17 000 universities.[2] Aalborg is fourth in the world within the field of engineering, and in Europe, it is ranked in first place.[3] As of 2018, Aalborg University is ranked 23rd among the world's universities under 50 years old. This makes the university the highest ranked Nordic university in the category. The rank today is also a significant climb from 2013 when it was ranked 71st out of the 200 universities included in the list.[4]

Aalborg University's position as a regionally based university, a national university with campuses in both South Denmark and the Capital Region, as well as an internationally established top-class university gives it a unique position as an actor in the development of regional and national innovation policies as well as being a prominent global partner in knowledge transfer, entrepreneurship, and education.

The study format at Aalborg University is problem-based and conforms to the model of Problem-Based Learning (PBL). The PBL model is characterised by problem-solving group work based on real-world projects that are often performed in collaboration with businesses. Fifty-three per cent of the university's master theses are conducted together with external organisations where students work with companies and public institutions throughout their education.[5] Recently, in a MIT report,[6] Aalborg University was classed fourth in the world among engineering education institutions. Altogether, this reflects that Aalborg University is able to combine a cross-disciplinary project-oriented teaching model with excellent research that is linked to its regional setting. These key factors enable Aalborg University to not only realise its own ambitions with respect to education and science but also to provide it with the necessary tools to be an active player in the regional innovation agenda.

Since its establishment in 1974, Aalborg University has grown from being a small university with only 1 635 students and 421 employees[7] to having

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2 https://www.en.aau.dk/research/ranking/.

3 https://www.usnews.com/education/best-globaluniversities/search?region=&subject=engineering&name=.

4 https://www.aau.dk/forskning/ranking/placeringer/.

5 Aalborg University Annual Report, 2017.

6 http://neet.mit.edu/wp-content/uploads/2018/03/MIT_NEET_GlobalStateEngineeringEducation2018.pdf.

7 https://www.en.aau.dk/about-aau/figures-facts/1974-2012/.

20 654 students and 3 730 employees[8] in 2017. This has not only had an impact on the university's position nationally and internationally, but the influence on the region has likewise been immense. Even though the region has seen a decline in the number of employees in regional businesses from 319 389 in 1996 to 274 420 in 2016, the number of employees with a university degree increased from 12 220 to 27 545.[9] With more than 19 000 students at the campus in Aalborg as well as 3 700 employees, Aalborg University is a large economic factor in the region. Almost six out of ten graduates from the university get a job in the private sector.[10] Aalborg University has indeed been a regional success.

The main campus of Aalborg University is based in the North Denmark Region. This puts the university in a unique position to play a key role in contributing to the development and execution of the regional innovation agenda and strategic regional innovation objectives. A long-standing cooperation with the municipality and regional growth centre provides continuous interaction between the university and the office for regional development (North Denmark Region). The two parties have a strategic cooperation agreement, stating joint aims on regional innovation.

In our efforts to continuously strengthen the relationship with the region's businesses, Aalborg University has developed a collaboration structure where companies can increase and mature their engagement with the university over time. This facilitates a cooperative learning process and offers a way for the many non-innovative firms in the region to start engaging in R&I relationships with the university and gradually strengthen these ties. These types of cooperation between regional businesses and the university range from innovation workshops involving students, student projects, and internships to cooperation in clusters and networks and, especially for strong and innovative companies, more contractually binding cooperation such as industrial PhDs, technology transfer, and research projects.

In the North Denmark Region, most companies have less than five employees. Forty per cent are one-man businesses, and only 10% have more than 20 employees. The university's collaboration structure accommodates and mirrors the needs of the region's large number of small companies and provides them with opportunities to gain and use knowledge from the university. The structure has been a driving force in the region's transfer from an industrial society to a more knowledge-based society.

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8 https://www.aau.dk/om-aau/aau-i-tal/.
9 Data provided by Region North Denmark: www.rn.dk.
10 Aalborg University Annual Report, 2017 with data from Danmarks Statistik.

Aalborg University is an active member in several international networks such as the European Consortium of Innovative Universities (ECIU) and the Conference of European Schools for Advanced Engineering, Education, and Research (CESAER), the former having a strong focus on regional innovation activities. As one of the original members of ECIU, Aalborg University has taken an active part in addressing and exploring innovation on all university levels such as best practice, new ways of collaborating, innovation ecosystems, and promotion of entrepreneurial research, education, and innovation. Together with the ECIU member universities, Aalborg University has worked with the HEInnovate assessment tool[11] to both improve the assessment tool and to actively use it for developing the university's innovation potential. Aalborg University's profile and approach to collaboration and innovation have established Aalborg University's leading role as a regional, national, and international pioneer in pursuing an innovation agenda.

C.2 REGIONAL ORIENTATION, STRATEGIC DEVELOPMENT, AND KNOWLEDGE INFRASTRUCTURE

Aalborg University considers knowledge transfer and cooperation to be integral parts of the university's DNA. These activities are conducted on several levels, focusing not only on traditional activities of knowledge transfer such as patents, spin-outs, licences, contracts, and research projects but also on informal activities of knowledge transfer such as networks, students–business cooperation, and engagement in well-established national and regional trade promotion activities.

To facilitate and support researchers, educators, and students in these activities, Aalborg University relies on a well-established innovation department (AAU Innovation). The innovation department is deeply rooted in research and education, as well as embedded outside the university in networks, clusters, municipalities, and local business organisations. This way, AAU Innovation is best suited to establish potentially fruitful connections between the university's students and researchers and its many partners. The innovation department supports not only formal knowledge transfers regulated by law, namely contracts and technology transfer, but also entrepreneurial activities, strategic

[11] HEInnovate is a self-assessment tool for Higher Education Institutions which wish to explore their innovative potential. The European Commission and the OECD have joined forces in the development of HEInnovate. It is free, confidential, and open to anyone to use (source: https://heinnovate.eu/en).

funding support, and matchmaking activities. AAU Innovation also provides targeted counsel and support to researchers and organises activities.

The university's focus on collaboration with regional businesses has supported the North Denmark Region's transfer from being an industrial society in the past to a far more knowledge-based society today. Over the years, the partnership between Aalborg University, the Office for Regional Development, and the North Denmark Region has developed and established itself as being mutually beneficial. A strategic cooperation agreement provides common interests and combines the university's strategy with the North Denmark Region's strategy for regional growth and development. The agreement states that Aalborg University and the North Denmark Region will work closely together to improve the development of regional strategic positions of strength. The focus is especially on regional clusters of excellence such as the regional ICT cluster, Brains Business, and the regional hub for energy, House of Energy. Furthermore, the university and the region work together to strengthen entrepreneurship in the North Denmark Region and to retain more graduates in regional companies.

Because Aalborg University and the regional companies are especially strong within the fields of ICT and energy research, well-established regional clusters are embedded in these progressive research communities. The engagement in a cluster has proven beneficial for many businesses as the interaction between companies, regional municipalities, and the university provides a triple helix setting for business development. At the same time, Aalborg University works strategically and is dedicated to adding a fourth element to the triple helix, making it a quadruple helix. The fourth element is civil society and the media, and this strategic approach emphasises the university's acknowledgement of its social responsibility in addition to its role of educating and conducting research. It is also in line with the European Union's approach to developing a competitive and knowledge-based society for the future.

Examples of Aalborg University's commitment to its social responsibility are:

- Lead in creating a 'Universitarium', where children can learn and be engaged in scientific play.[12]
- Making megatrends in society strategic focus areas for research and innovation, e.g. the UN Sustainable Development Goals.

Aalborg University's engagement in science, the region, businesses, and society make it a desired strategic partner for many companies. A report from the Confederation of Danish Industry has established Aalborg as the No. 1

[12] https://www.universitarium.dk/om/.

university in Denmark for businesses to collaborate with. On a scale from 1 to 5, where 5 is 'very satisfying', Aalborg University scored 3.9 with a big gap down to the second placed university with a score of 3.3. The average score for the six Danish universities was 3.0.[13]

According to the report from the Confederation of Danish Industry, Danish companies especially benefit from Aalborg University's agile, pragmatic, and accommodating approach to cooperation. These conclusions are supported by an analysis and mapping of Aalborg University's engagement with companies and public institutions from 2017. The analysis shows that 85% of the companies find that their partnership with Aalborg University is fruitful and characterised by strong communication. Furthermore, more than 80% agree that Aalborg University is very observant and understanding with regard to the company's needs. Almost the same percentage of companies found that Aalborg University is excellent at matching expectations.[14]

C.3 EDUCATION AND HUMAN RESOURCES DEVELOPMENT

All degree programmes and research activities at Aalborg University are PBL oriented and have a clear interdisciplinary focus. Universities, researchers, and students have nationally and internationally recognised the university's PBL pedagogical model as advanced and efficient. The statements are underlined by the fact that UNESCO has placed its only Danish chair in PBL at Aalborg University.

Through strong interplay between staff and students and with intense collaboration with public and private sectors, Aalborg University offers world-class teaching and degree programmes with a real-world approach. In a MIT report,[15] Aalborg University was appointed fourth in the world among engineering education institutions.

Among MIT's reasons for naming Aalborg University one of the world's leading institutions within engineering education are:

- Aalborg University is focused on continuously developing its educational programmes.

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[13] https://www.danskindustri.dk/arkiv/analyser/2018/2/danmark-tilbage-pa-vidensporet-iv/.

[14] http://www.aau.dk/digitalAssets/307/307540_aalborg-universitets-vidensamarbejde-effekter.pdf.

[15] http://neet.mit.edu/wp-content/uploads/2018/03/MIT_NEET_GlobalStateEngineeringEducation2018.pdf.

- Aalborg University is extraordinarily successful in making great graduates out of students who initially did not have the required skill set.
- Aalborg University has a strong evidence-based approach to teaching, which makes the university a current leader in engineering education. The report from MIT highlights Aalborg University's investment in developing new models of problem-based learning for the digital age with a view to implementing such approaches at the university.

The PBL model teaches students to acquire knowledge and skills independently and to work in an interdisciplinary way and to be problem and result oriented. This makes the model ideal in preparing the students for working together with the business community, which not only develops the students' academic skills but also hones their skills in team work and cross-disciplinary cooperation. The PBL teaching method makes the candidates at Aalborg University a sought-after resource in the labour market, as they can work both independently and with other professionals. Throughout their education, students work on real cases, interacting with companies and public institutions, and the university's approach to teaching leaves the students well prepared for real job situations.

To keep the university as a world leader in education, Aalborg University will invest DKK 9 million over the next three years in further developing its approach to teaching. The new teaching model is likely to bring mixed method approaches to problem-based learning. This will be supported by virtual projects, international linkages, and online learning.

In order to ensure the success of its students and graduates, Aalborg University publishes a guide once a year, which gives businesses an insight into the different educational programmes at the university and what skills the students hold.[16] The guide is designed so that businesses can search for certain skills and then find out which programmes they should hire candidates from. It is a way for the university to present to the business community its graduates' skills instead of graduates with hard to understand titles. For the businesses, it becomes far easier to find the next valuable employee. Aalborg University also promotes students to businesses as potential collaborators on projects or workshops. Collaborations during study years often lead to employment after graduation.

Aalborg University's graduate analysis from 2017 showed that 67% of graduates collaborated with a company or public institution as part of a project during their academic education. The same analysis showed that 31% of the graduates secured a job before the end of their education and a further 31% had

[16] http://www.e-pages.dk/aalborguniversitet/534/html5/.

a job within 0–3 months[17] and 57.6% of graduates from Aalborg University found employment in the private sector.[18]

C.4 RESEARCH, TECHNOLOGICAL DEVELOPMENT, AND KNOWLEDGE TRANSFER

Knowledge transfer is conducted on many levels at Aalborg University. The university's researchers produced 5 415 research publications in 2017, engaged in 2 945 research projects with external partners, and conducted 1 225 student projects in collaboration with companies.[19] Twenty-nine Danish researchers are among the world's most cited and seven of those are from Aalborg University.[20] However, the more traditional technology transfer activities such as patent applications, inventions, licences, and spin-outs are also an integrated part of Aalborg University's way of exchanging and sharing knowledge (see Table C.1). As in all other aspects of knowledge transfer, collaborations between the university and companies play a significant role.

Table C.1 Key figures on research, technology and innovation (2017)

Research publications	5 415
Teaching and dissemination publications	569
Patent applications	16
Sold and licensed inventions	42
Spin-out companies	1
Reported inventions	71
Number of student projects with companies	1 225
Number of external projects	2 945
Financial extent of cooperation with companies	€152M

An increase in technology transfer from 2006 onward marked a change in Aalborg University's commercial strategy. Since 2006, the university has dedicated staff to all aspects of technology transfer, in-sourcing the entire commercial process and limiting patenting to where it makes sense commercially as well as strategically. This change has led to Aalborg University being the university in Denmark that sells most inventions and discoveries. From

17 http://www.e-pages.dk/aalborguniversitet/666/html5/.
18 Aalborg University Annual Report 2017 with data from Danmarks Statistik.
19 Aalborg University Annual Report 2017.
20 https://www.aau.dk/digitalAssets/418/418275_aau_1974-og-2018.pdf.

2012 to 2016, Aalborg University was behind 36% of all commercialisation of research outputs.[21]

Figure C.1 shows the number of invention disclosures in relation to the number of commercial technology transfers between 2000 and 2014. The statistics are compiled on the basis of the official data on the commercialisation of research results. This is published annually by the Danish Agency for Science, Technology, and Innovation. The number of commercial technology transfers reflects the sum of licence fees, sales, and opposition agreements as well as the number of established spin-off companies.

At Aalborg University, an agreement about transferring technology to a company is often combined with a close collaboration between the company and relevant researchers. A partnership ensures that technology is transferred or licensed in the best possible way and also makes it possible for the company, the inventors, and the research staff to further develop the technology to suit the company's needs. This way of addressing technology transfer also encourages and develops cooperation between companies and researchers. The approach is adopted in licensing, sales, and spin-outs, making technology transfer at Aalborg University not just about patenting but just as much about enhancing cooperation between researchers, students, and companies. Each year, Aalborg

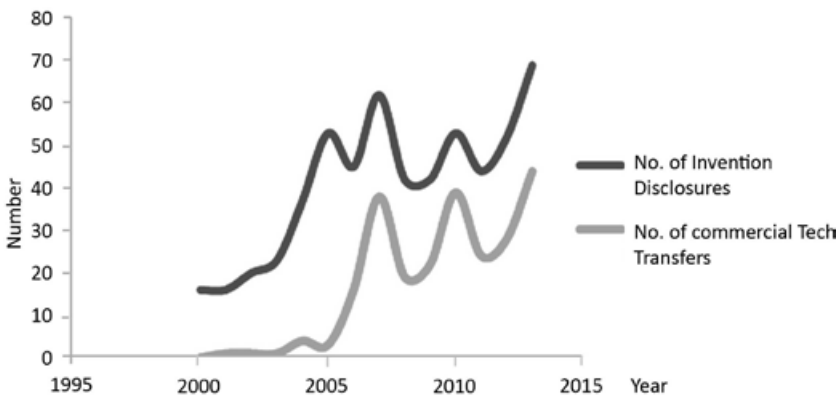

Figure C.1 Invention disclosures and commercial technology transfers

[21] Ministry of Education and Research (2016). Knowledge for growth: Public–private interaction on research (average for the period 2012–2016); Uddannelses- og Forskningsministeriet (2016). Viden til vækst: Offentlig-privat samspil om forskning (gennemsnit for perioden 2012–2016).

University negotiates 300–400 contractually binding research collaborations with both public institutions and private companies.[22]

Aalborg University provides companies with the possibility to test an invention through Open Innovation Licensing (OIL) before buying it. This online platform supports innovators in their quest for knowledge by making new technological inventions easily and conveniently accessible. Whether you are a company representative, researcher, or student, OIL can provide the necessary technology for your latest project. Aalborg University believes in risk-free technology licensing, and this platform provides the user with a trial licence. The licensing system makes sure that technology matches the intended needs and that it integrates well within the organisation before the user pays for it. The OIL programme introduces a two-step licensing process, enabling clients to try technologies on non-commercial terms before signing on for a commercial licence.

C.5 ENTERPRISE DEVELOPMENT AND ENTREPRENEURSHIP

Aalborg University has set a vision for 2021, which includes:

- All students must graduate with the knowledge and skills to create their own company;
- All students must be highly employable;
- The university is recognised for its ability to develop start-up companies;
- The university must develop an evidence-based method for creating entrepreneurs;
- A goal is to create 1 000 entrepreneurs within the next strategic period (2021–2026).

These ambitious goals are founded in a long-standing tradition of working with visionary entrepreneurs as well as the general strong ties between the PBL teaching model and entrepreneurial methods and thinking.

As a modern university, Aalborg University is expected by both students and stakeholders to support entrepreneurship and enterprise development. It is part of a deep-rooted culture, deriving from the foundation of the university, and many of the leading and pioneering companies in the North Denmark Region have indeed been founded by graduates from Aalborg University.

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[22] Ministry of Education and Research (2016). Knowledge for growth: Public–private interaction on research (average for the period 2012–2016); Uddannelses- og Forskningsministeriet (2016). Viden til vækst: Offentlig-privat samspil om forskning (gennemsnit for perioden 2012–2016).

With its geographic location and distance to the capital, the North Denmark Region has had a long history of needing to set up its own structures to support entrepreneurship in a region with few investors and only little risk capital. In the past 15 years, Aalborg University has been able to secure funding from private foundations to build early-stage funding programmes for research-based entrepreneurs. Supporting Entrepreneurship at Aalborg University (SEA) has worked with both students and researchers to manage programmes since 2003 for students and the incubator, as well as to advance entrepreneurial education in collaboration with researchers and professional business developers. It is paramount for Aalborg University to further develop its entrepreneurial activities, and the university's strategy focuses directly on developing a flexible incubator environment. This is underpinned by both the incorporation of entrepreneurial activities in the PBL teaching method and by promoting an entrepreneurial mind-set in the students and researchers. Aalborg University also accomplishes this by engaging in more professional entrepreneurial activities such as extracurricular entrepreneurial classes and guidance in business development.

Aalborg University works closely with regional business partners, the regional Growth House, and the municipality to establish cross-organisational entrepreneurship activities, which support entrepreneurs throughout their business development. By doing so, the university facilitates the continuous support of entrepreneurs even when they move from student to graduate to alumni.

Aalborg University has more than 100 different courses or study programmes on entrepreneurship for students who want to start their own company. Entrepreneurial activities are also incorporated in the regular teaching to develop the students' entrepreneurial mind-set and prepare them for work in the challenging environment of many real life companies. AAU Innovation also supports entrepreneurship by developing entrepreneurial processes that can be integrated into educational programmes.

In 2017 alone, 72 teams worked in the university's incubator, and Aalborg University's business developers worked with more than 200 students.[23] The entrepreneurial mind-set is essential in all aspects of education at Aalborg University.

To promote the international dimension, Aalborg University also cooperates with other universities in Europe. Amongst others, the university has joint entrepreneurial activities with Dublin City University and works within the frame of the European Consortium of Innovative Universities (ECIU).

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[23] Data source: AAU Innovation entrepreneurial team.

Aalborg University also works hard to make strong ties to the business community. The concept of 'co-location and co-creation' is blossoming all over Europe. It is a new way of thinking and creating knowledge that bridges universities and society. The approach of co-creation is also an inseparable part of Aalborg University's DNA. It builds on the understanding that research, education, and practice are integrated and create mutual impact. The other key element in the concept of co-location and co-creation is the belief that co-location breeds co-creation. This belief forms the basis for the way each campus at Aalborg University is set up so that companies located on site pave the way for day-to-day and long-term strategic cooperation between researchers, students, and the embedded companies.

The aim of Aalborg University's collaboration with the business community through companies located on campus is:

- To promote, enhance, and utilise binding collaboration between the university and the business community;
- To enable the university's knowledge to become influential in the outside world;
- To ensure practical and theoretical contributions from collaborative companies;
- To support business development by promoting initiatives in establishing start-ups and by promoting business incubation.

Co-location and co-creation are not about a link to the university via a science park facility; they are all about being located and embedded in the research and student communities at campus. Hereby, the business community stimulates and creates an innovative ecosystem at campus, which contributes to the larger ecosystem in the surrounding region. Through collaboration with the university, the business community can hopefully have an international research-based impact.

C.6 VISION AND STRATEGY FOR THE NEAR FUTURE

Aalborg University currently consolidates and further develops its profile as a dynamic and innovative research and educational institution that is oriented towards the world. Over the past three years, the university has experienced a 50% increase in earnings from the university's cooperation with external partners. External funding is expected to increase going forward.

The university's focus on interacting with its surroundings on both a small and large scale is fundamental in its strategy 'Knowledge for the World'. The strategy sets the framework and ambitions for the core activities of research,

education, and knowledge cooperation. Because knowledge cooperation is an integral part of the strategy for excellent research and education, it also plays a vital role in the daily work for both students and researchers. 'Knowledge for the World' is filled with great ambitions for knowledge cooperation to be both an integral part of research and education and in consolidating Aalborg University's position as a leading engaged university. The university's dedication to developing the areas of innovation and cooperation becomes evident in its strategic focus as well as the construction of a new Science and Innovation Hub.

The Science and Innovation Hub will be housed in a new building which provides space for both lively research and focused concentration in order to promote innovation and the development of new ideas. The users will be able to inhabit a new type of non-programmed workshop space ('garages') referring to the architectural framework for some of the world's most successful entrepreneurs. In these garages, the users define their own rules and methods of co-working, creating spaces for new ideas to flourish. The garages are the innovative basis for informal learning, acting as a supplement to the formal education and research offered at Aalborg University. The new Science and Innovation Hub building will be ready in 2021 and will form the physical surroundings for Aalborg University's entrepreneurial, innovation, and cooperation activities. The Science and Innovation Hub is and will be supplemented by thematic incubators placed in research labs. At present, there is one incubator hub at Aalborg University, but work is being done on establishing four more: in Copenhagen, Esbjerg and two more in Aalborg. The three incubator hubs in Aalborg will have different foci. As an example, one will focus on health.

Starting in 2019, Aalborg University will initiate a project with data-driven management in innovation. Going forward, AAU Innovation will also work in a targeted way towards making the university's partnerships data-driven. This means that, in the future, the university will be able to:

- More clearly document the effects of collaborations with supportive data;
- Use data to make sure that the university has the right options for collaboration 'readily available'.

In 2018 and 2019 Aalborg University also conducted several analyses concerning entrepreneurship and collaborations with external partners. The aim of the analyses is to answer the following questions:

- A comparative analysis of entrepreneurship among Danish universities. How many entrepreneurs do the universities produce, who are they, and how do they fare?
- What kind of companies generally engage in collaborations with Aalborg University and how do they benefit from it?

Aalborg University has a cooperation agreement with the regional Growth Forum, which initiates and monitors projects and sets the strategic focus for the business development of the North Denmark Region. As the cooperation agreement is based on the strategies for both organisations, it combines the needs from the business community, the public institutions, and the university, providing a strong focus on common interests. As an example, the strategic cooperation agreement has a special focus on cooperation with small and medium-sized companies. This contributes to increasing the small businesses capacity for innovation and strengthens the level of innovative companies in the region, as well as to mature companies, for increased research cooperation with the university. This form of strategic cooperation agreement is expected to raise the number of highly educated employees within the region and to continuously support the region's transformation from a region of industry and agriculture to a highly developed technological and knowledge-based region.

Appendix D: Technical University of Turin[1]

Shiva Loccisano, Emilio Paolucci and Riccardo Ricci (Technical University of Turin, Italy)

D.1 INTRODUCTION OF THE UNIVERSITY AND ITS REGIONAL CONTEXT

The Technical University of Turin (in Italian 'Politecnico di Torino'; PoliTo for short) is a part public engineering university based in Turin, Italy. Founded in 1859, it is Italy's oldest technical university, formerly being known as the 'School of Application for Engineers'. From when it was first established until approximately 1999, its main role was to transmit knowledge within the local ecosystem through highly educated and skilled students and graduates. Since 1999, after the founding of the university incubator, the role of the university has progressively changed. PoliTo nowadays is a more complex institution that focuses not only on teaching but also on scientific research, technology and knowledge transfer.

According to the world university rankings, in 2018, PoliTo is in 387th position in the QS World University Ranking and 33rd position in the 2018 QS World University Ranking for Engineering and Technology. In addition, the QS World Graduate Employability Ranking has placed PoliTo in first position, with reference to the 'Graduate Employment Rate' indicator (within 12 months of graduation), attesting to the quality of its education and its reputation among firms. Table D.1 summarises some information related to PoliTo for the years 2011[2] and 2017.

[1] The (re-)numbering of sections, tables and graphs in this appendix was done by this book's editors, as well as other minor edits to ensure text and format consistency across appendices B to F.

[2] We opted for 2011 as a complete set of data was available for that year.

Table D.1 PoliTo key facts and figures (2011 and 2017)

	2011	2017
Total Budget	€186.1M	€250M[1]
# academic staff (FTE)	887	878
# students	28 631	31 000 (15% foreign students)
# research publications[2]	2 290 (2013)	2 810
% of top 10% publications[2]	13% (2013)	15%

Notes: [1] Approx. 50% originates from the Italian Ministry, 10% from students' tuition fees and 40% from competitive research grants. [2] Sources: ETER, Elsevier (SCOPUS database and SciVal), PoliTo database.

Although PoliTo performs most of its activities in the Turin metropolitan area, which is identifiable at a NUTS3 level, it is also active at a regional level. In 2017, the Regional Innovation Scoreboard (RIS) classified the Piedmont regional economic system as 'moderate + innovator', a classification that is very close to the upcoming grade (Strong Innovation Leader). The Piedmont region has several local firms which have strong research and innovation capabilities. RIS, in fact, shows that Piedmont has a relative advantage in the 'private R&D expenditure'[3] and 'SMEs innovating-in-house' indicators, with respect to other European regions.

Until approximately 1990, Piedmont and the Turin metropolitan area were characterised by the presence of the Fiat[4] car-maker and its suppliers, as well as other large companies, such as Telecom Italia, Leonardo, Thales, Comau, Magneti Marelli and Ferrero. A wide chain of small businesses clustered around these large companies that operate in industries such as automotive, aeronautics, telecommunications and textile. Over time, the region has developed high innovation capabilities in these technological specialisation areas and a strong network of relationships among local industrial actors. PoliTo has always had close relationships with such large firms, in the form of partnerships and research collaborations, as well as through the supply of a constant flow of skilled engineers and architects.

The engagement and impact of PoliTo within the regional ecosystem have progressively increased from the 1990s, when the Turin area underwent a profound transformation that was caused by the Fiat crisis and the contemporaneous prolonged crisis of the Italian economy, increasing international competition, together with the joint decline of traditional industries, and the rise of the knowledge-based economy. In those years, large companies started

[3] Regional Innovation Scoreboard, 2017.
[4] Now Fiat Chrysler Automobile (FCA).

moving their production to other countries and, consequently, the SMEs and the entire Turin economy were affected to a great extent. In order to overcome the crisis, the regional government developed a new strategic plan,[5] with the aim of defining priorities, in terms of regional specialisations. The plan of the regional government gave a key role to the university system in this technological specialisation process. In that period, and in line with the regional strategic plan, PoliTo adopted a number of actions that were aimed at supporting the ongoing transformation towards a more diversified economic system, adding more cross-disciplinary general-purpose technologies (namely ICT) to the traditional manufacturing competences, while favouring the creation of such new industries as biotechnology, mechatronics, biofuel, advanced materials etc. In so doing, PoliTo built formal and stable collaborations with local firms, in the form of collaborative research, contract research, consulting, joint ventures, joint participation in EU funded programmes, etc. PoliTo also founded two different research centres (ISMB[6] in 2000 and SITI[7] in 2002) in partnership with several large companies (Telecom Italia, Motorola, Fiat, ST Microelectronics, etc.) and local public institutions (e.g. the Compagnia di San Paolo Foundation). The mission of these centres was to develop internet-based technologies and to promote their adoption in such traditional sectors and in areas such as logistics, territorial safety, environmental protection and urban renewal.

The following sections offer further detail about these changes and the contribution of PoliTo to its regional ecosystem has been divided into four impact categories as provided by the RIIA[8] framework.

D.2 REGIONAL ORIENTATION, STRATEGIC DEVELOPMENT, AND KNOWLEDGE INFRASTRUCTURE

Over the last 20 years, the key objectives of the regional government have been to renew traditional manufacturing industries and to diversify through the introduction of other industries. The decision to work on how to diversify the regional economic system was also a response to the international economic crisis of 2007–2008 and to the increasing international competition. The regional government has always considered PoliTo and UniTo,[9] thanks to their

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5 DOCUP (Documento unico di Programmazione) in 2000–2006.
6 Istituto Superiore Mario Boella.
7 Istituto Superiore sui Sistemi Territoriali per l'Innovazione.
8 Research and Innovation Impact Assessment.
9 The other large university in the Turin area, which focuses on Basic Sciences and Humanities (www.unito.it).

high-quality research and knowledge transfer, as a key means of developing new technological specialisation trajectories. PoliTo has collaborated with the region in the development of its strategic plans and has always been a key partner in their implementation.

As a result, PoliTo has continuously renewed its overall strategy over the last 20 years, adding new activities to the core missions of research (mostly in collaboration with local industrial players) and education for graduate students and industry members. Similarly, knowledge and technology transfer, once exclusively oriented towards large companies to help them solve specific technical problems, has changed to become more coherent with regional policies. The exploration and exploitation of new technological trajectories that were absent in the local industrial ecosystem has helped create new regional specialisation opportunities. For example, in 2005, a key initiative was undertaken, that is, the creation of a business research centre aimed at attracting the research laboratories of local and international firms (e.g. General Motors, Pirelli, Microsoft, Vishay, FEV) to the PoliTo campus in order to support the 'cross-fertilisation' of knowledge from different domains and to develop new forms of industry – university collaboration.

PoliTo also introduced innovations to the organisational model of the Technology Transfer Office (TRIN) by reinforcing its ability to manage administrative and legal issues, introducing a research centre on Entrepreneurship and Innovation, which provides research and methodological support to technology transfer activities, and supports the policy and adoption of new practices, and a new unit (called 'Lab TT') that acts as a liaison between TRIN and the traditional departments (Figure D.1).

The last step undertaken in order to develop a critical mass in new research domains was the creation, in 2016, of 11 cross-departmental research centres, which have been closely engaged with firms and other actors in the regional ecosystem and have focused on the development of breakthrough technologies (i.e. additive manufacturing, photonics, power conversion, autonomous vehicles, etc.). As a final result of all these transformations, PoliTo now has a dual strategy in place, whereby technology-push is mixed with market-pull, based on two main pillars: (1) generation and exploration of new knowledge for long-term innovation and diversification of the regional economic system; (2) exploitation of research results to drive the economic and societal impact in the medium to short term.

Overall, these actions have been consistent with PoliTo's strategy of leveraging knowledge accumulated from research over time at the local level through applied research projects developed in collaboration with firms. This approach has thus contributed to strengthening the network of relationships within the local ecosystem and to increasing the technological proximity between PoliTo and local firms. The ability of PoliTo to support the existing

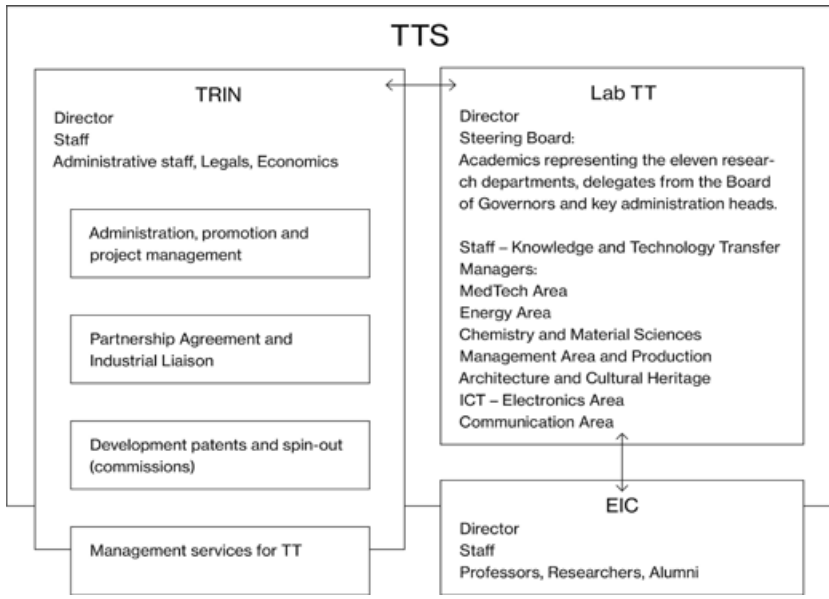

Figure D.1 TTO organisation model at PoliTo

technological specialisation has been confirmed by recent research[10] that shows how, in the period from 1999 to 2013, PoliTo and firms in Piedmont patented in the same technological areas, and that PoliTo accompanied large companies in the exploitation of new technological areas. Since 2014, a new direction of strategic development has helped to strengthen and diversify the region's technological specialisation, as PoliTo has started to file patents in new technological areas. This strategic development has been consistent with regional policies. Indeed, the focus of both regional 'platforms' and 'clusters' programmes has also been targeted to new emerging fields (such as biotechnologies, health sciences and mechatronics) in order to generate a 'cross-fertilisation' between traditional and new industries. At the same time, PoliTo's exploration approach has been consistent with the European Commission's objective of stimulating 'excellence in research'. In fact, PoliTo has started exploring new technologies and has developed new competencies (i.e. nanomaterials, bioengineering, energy storage, etc.), mainly by conduct-

[10] Colombelli, A., De Marco, A., Paolucci, E., Ricci, R. and Scellato G. (2019), University technology transfer and the evolution of regional specialisation: the case of Turin, PoliTo working paper.

ing research projects financed within the EU's 6th, 7th and 8th Framework Programmes.

The PoliTo strategy has had a significant impact on the regional ecosystem. The number of patents and spin-offs is increasing and collaboration with companies is growing (there are 36 long-term partnership agreements in place, the industry co-patent rate is 53.7% and the co-publication rate with industry is 6.8%). PoliTo, together with its I3P Incubator, has been a key leading actor in creating a new entrepreneurial ecosystem in the Turin area.[11] In fact, on average, 54 from every 1 000 graduates found a new company. PoliTo also plays a key role in connecting the regional innovation system with international research networks. For example, it has been engaged in 12 European Research Projects funded by the ERC, of which ten have been approved as 'Principal Investigator' and two as 'Partner Institutions'. It is also participating in two EU FET Flagship Initiatives: Graphene and the Human Brain Project. Moreover, 45.4% of the publications in scientific journals have had at least one foreign author. These data demonstrate the strategic intention of the institution to adopt an international orientation and to create links between regional and international actors.

D.3 EDUCATION AND HUMAN RESOURCES DEVELOPMENT

Currently, PoliTo provides teaching to approximately 33 100 students, of which around 15% are foreign students[12] and 45% are Italians from outside Piedmont (students tend to choose PoliTo because its employability rate is higher than several other Italian universities). Around two-thirds of the courses are given in English, and courses are provided to around 700 PhD students (the funding of many PhD grants comes from local and international companies).

The quality of education has been rated highly by students. A recent graduate survey, conducted by AlmaLaurea[13] in 2017, revealed that nine students out of ten appreciate their degree course (Figure D.2a). Similar results were obtained in terms of satisfaction with the degree for the job performed after graduation (Figure D.2b).

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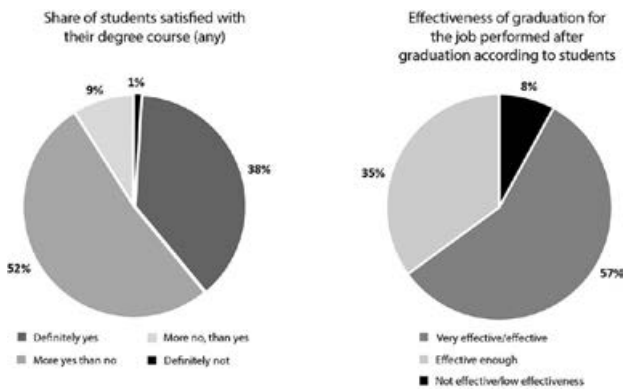
[11] Colombelli, A., Paolucci, E. and Ughetto, E. (2017), Hierarchical and relational governance and the life cycle of entrepreneurial ecosystems. *Small Business Economics*, 1–17.

[12] Selection procedures also take place in Buenos Aires, Santiago and Beijing.

[13] AlmaLaurea is an association that was founded in 1994 which annually collects statistics from the associated universities. It is compulsory for almost graduated students to submit an online survey before they can graduate. This ensures a high number of responses.

The 2017 QS World Graduate Employability Ranking, pertaining to the 'Graduate Employment rate' indicator assigned first position in the world to PoliTo, and the AlmaLaurea survey revealed that employment within a year after graduation was close to 90%. PoliTo also promotes the retention of graduate students in the Turin area. In fact, the same AlmaLaurea survey revealed that 71.1% of graduate students (7 out of 10) would be willing to work in the Turin Area, and this choice was followed by the province of residence (62.9%), North Italy (62.2%), the Piedmont Region (62.0%) and another European country (60%). Moreover, the university invests in retaining promising researchers as it has decided to increase the standard national grant for PhD students by 25%. PoliTo is also actively involved in connecting education with industry, since more than 90% of its students participate in a traineeship in a company.



Source: AlmaLaurea 2018 Survey – 2017 Graduates' Profile.

Figure D.2a and D.2b Education quality

In order to increase the quality of education, PoliTo has also developed its internationalisation activities, thanks to the 463 partnership collaborations with other universities, and more than 1 000 incoming and 1 000 outgoing Erasmus students.

However, the education carried out by PoliTo is not only addressed to students, but also to members of industry and graduate students. In particular, PoliTo collaborates with local industrial associations to provide post-degree courses in order to develop new competencies for managers and employees. Currently, it provides such teaching programmes, focused on new technologies, to about 550 students (including graduate students and managers).

In recent years, PoliTo has strategically invested in entrepreneurship education to foster an entrepreneurship mind-set in students and young researchers. Around 4–5% of bachelor students attend at least one course on entrepreneurship or innovation. PoliTo also offers several elective courses on entrepreneurship and innovation at the BSc, MSc and PhD levels. For example, since 2014, it has hosted the European Innovation Academy, an intensive summer entrepreneurship school in which about 500 international students (including students from the Politecnico di Torino), guided by renowned mentors and with the sponsorship of multinational firms and international institutions, are challenged to transform their ideas into a technology start-up while working in a multidisciplinary and international team. Since 2015, in partnership with CERN and the Agnelli Foundation, it has offered Innovation for Change, an entrepreneurship programme for about 60 students (PhD and MBA) with the objective of identifying solutions to long-term challenges proposed by large companies. Moreover, it has very recently created a 'fab lab'-like programme for bachelor students and has received funding from MIUR[14] for new, cross-disciplinary educational programmes. A common feature of all these courses is the fact that students' activities start from challenges made available by companies, research centres, universities, start-ups, and so on.

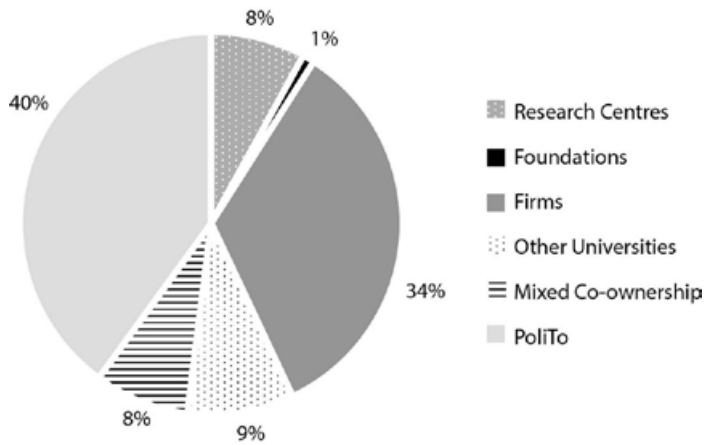
D.4 RESEARCH, TECHNOLOGICAL DEVELOPMENT, AND KNOWLEDGE TRANSFER

PoliTo has an average of 14% of the total top annual publications cited in their own specific scientific field. This demonstrates the high-quality research of its faculty. Similarly, the institution is committed to transferring the knowledge obtained from research to the ecosystem. In fact, PoliTo's Statute clearly recognises the importance of the valorisation of research results. The university's 'third mission'; its contribution to economic and social development of the region, has been managed by the TRIN, supported by the I3P Incubator.

PoliTo's Proof of Concept (PoC) programme, a new key initiative, has determined a further positive impact that has accelerated the pace of spin-off creation and growth. PoliTo acts as a proactive investor by addressing the most critical phase in the innovation process between invention (when Intellectual Property is created) and technology development, when commercial concepts are created and verified, and proper markets are identified. The PoC pro-

[14] MIUR is a funding instrument of the Italian Ministry of Education, Universities and Research to support excellence in Italian universities (https://www.miur.gov.it/dipartimenti-di-eccellenza).

gramme has two annual calls and funds of €50 000. An analysis of completed PoCs reveals that the programme has increased the Technology Readiness Level by two stages on average, from around 3 to 5; it has also created new opportunities for patent licensing and start-up creation, proving that PoliTo improved its ability to transfer research into industrial applications. In fact, the spin-offs created in the 2017–2018 period received around €2 million (before incubation), with a post money value of around €10 million. It is also worth noting that the CEOs of such start-ups were all post-docs who had attended the new courses on entrepreneurship creation at PoliTo.



Source: PoliTo data.

Figure D.3 Patent co-ownership as a percentage of the total patent applications

The TRIN performs a range of activities across four broad categories:

(1) Research Commercialisation: With more than 600 registered patents and 53 university spin-off firms (in the last 15 years), PoliTo can be considered a leading university in technology transfer, both in Italy and the EU. The focus on collaboration with the ecosystem can be confirmed by the fact that around 50% of the patents are co-owned with local companies or research centres (Figure D.3) and there is a growing number of patent applications, but also patent licences to companies as well as the creation of spin-off firms (Figure D.4). In particular, there was an increase between 2015 and 2017, with 16 patents being licensed to firms and 23 to spin-offs. These technology transfer activities have generated

resources for PoliTo of around €1 million from different sources and around €0.7 million of options on patents.

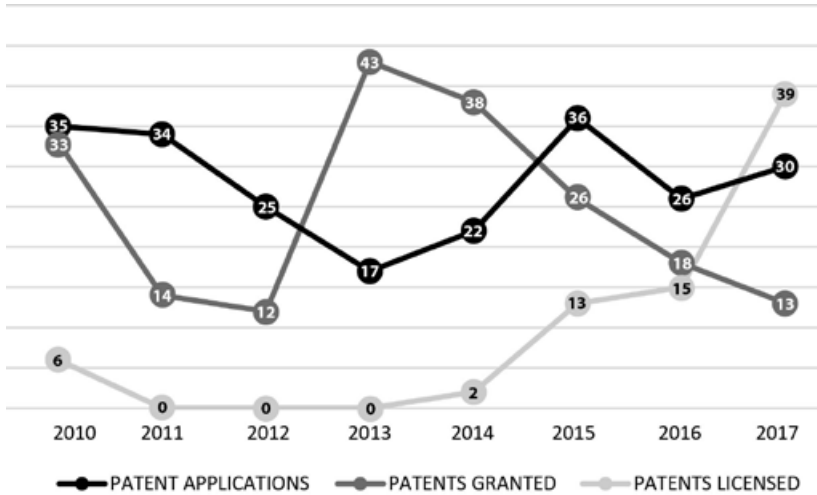
(2) Knowledge sharing: In order to increase the impact of research on the regional and national economy, PoliTo with the support of Banca Intesa and the Ministry of Economic Development, in 2016 set up a project aimed at creating a unique entry point (https://www.knowledge-share.eu/) for patents filed from most of the Italian universities and research centres. The objective of the Knowledge Share project is to increase the opportunities for SMEs to access the pool of patents (and the related technologies) in order to sustain their innovation processes.

(3) Support to technology development and spin-off creation: The general strategy of PoliTo as far as tech transfer is concerned is to provide support for 'inside-out' technology development and spin-off inception. The support provided by PoliTo, through TTO, consists of both 'soft' and 'hard' assistance: mentoring programmes, PoC funding, networking with local entrepreneurs, potential investors, or large companies. The incubator supports the growth of start-ups[15] and further funding stages. PoliTo's ability to internally increase the Technology Readiness Level (TRL) of research results has attracted the attention and investments of business angels (they have co-invested in some PoCs), venture capitalists focused on tech transfer and early stages, as well as local medium-sized companies that are looking for new technological opportunities. One successful case is the *ToothPic* spin-off, which resulted from an ERC research project, and which was the first investment ever in Italy based on EIF (European Investment Funds), specifically targeted at university tech transfer.

(4) Collaborative research with industry and engagement with the ecosystem: As mentioned in section D.1, PoliTo invested €30 million in 2016 to create 11 cross-departmental research centres that perform research on 'breakthrough technologies' (e.g. applied photonics, additive manufacturing, water technologies, artificial intelligence and big data). These centres are at the intersection of different scientific disciplines and therefore need new approaches. Such research centres share their infrastructures with large companies and SMEs. In addition, in 2015, PoliTo initiated an array of programmes aimed at developing new forms of collaboration with SMEs in collaboration with local industrial associations and other local actors. These programmes provide scientific tutoring and coaching services to obtain product and/or process innovations in

[15] It should be noted that the incubator is open to business ideas coming from outside the regional ecosystem as well.

SMEs. On an annual basis, the number of involved companies in such programmes is more than 100. Their objective has been to make PoliTo technologies available to a large number of SMEs. All these above activities have in fact been successful in turning knowledge from education and research into technology transfer (Table D.2).



Source: PoliTo TTO.

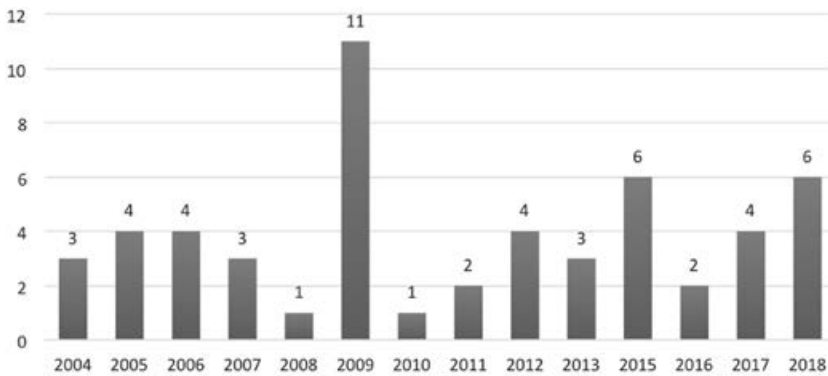
Figure D.4 Trends in patenting activities

Table D.2 Technology performance indicators

Invention disclosures since 2010	303
Patent applications since 2010	241
Patents granted since 2010	203
Commercialised patents since 2010	80
Patent co-ownership rate since 2010	59%
Spin-offs since 2004	54
Total start-ups launched by the incubator	224
Total amount of funding raised by portfolio companies since 2010	€5M

D.5 ENTERPRISE DEVELOPMENT AND ENTREPRENEURSHIP

Enterprise development and entrepreneurship have been a key concern since 1999, the year in which I3P,[16] a PoliTo incubator, was founded. This incubator is a non-profit joint-stock consortium that includes the Turin Chamber of Commerce, the City of Turin and the Province of Turin as shareholders. Since it was first set up, I3P has promoted and supported the creation and development of new enterprises by both PoliTo researchers, to exploit their scientific results, and by external entrepreneurs and/or established firms with new business ideas. The number of PoliTo spin-offs has increased gradually from 2004 to 2018 (Figure D.5), with a peak in 2009.



Source: PoliTo data.

Figure D.5 Spin-off firms produced by PoliTo

I3P has in fact been successful in introducing new companies (Figure D.6). The number of incubated companies has increased substantially throughout the period from 2011 to 2018. The incubated start-ups have determined a positive impact on the local economy and on employment. In fact, the total turnover and employment have risen gradually from 2011 to 2018, and, in 2016, they stood at 1 687 and €124 million, respectively (Table D.3). Investment in start-ups has also grown in the same period, reaching a 2017 peak of €3.02 million and €6.16 million for seed and early stage investment respectively.

[16] Incubatore Imprese Innovative del Politecnico di Torino (PoliTo Incubator for innovative firms).

I3P has therefore played a very important role in accelerating the diffusion of innovations that were generated in the PoliTo labs as well as of business ideas originating from the entrepreneurial ecosystem. It works from TRL 5–6 on, and together with PoliTo has created an entrepreneurial climate inside the university and the region, by means of specific events and meetings with industrial representatives, investors and other members of the business community.

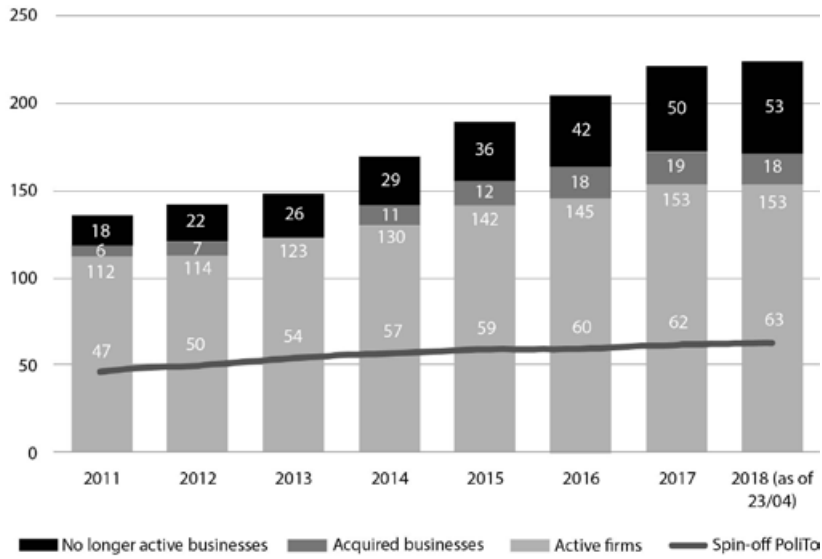


Figure D.6 Trend of start-ups incubated by I3P

Table D.3 I3P performance statistics

	2011	2012	2013	2014	2015	2016	2017
Total employment created by start-ups	672	778	1 176	1 408	1 515	1 687	2 207[1]
Patents owned by start-ups	78	74	78	70	86	97	103[1]
Total Turnover [M€]	44	50	61	75	94	124	[2]
Seed Investment [M€]	1.7	1	2.3	3	3.2	2.9	3.02
Early stage investment [M€]	5	-	-	2.5	8.2	5.15	6.16

Notes: [1] Estimated, [2] Not available.

D.6 VISION AND STRATEGY FOR THE NEAR FUTURE

In the future, PoliTo will continue its investments aimed at increasing the technological proximity with firms from the regional ecosystem. On one hand, the process is pulled by local firms with high innovation capabilities, and on the other pushed by research activities at PoliTo. In line with regional policies to achieve a balanced economy, it will continue its evolution from a strategy of exploiting competencies that are already part of the local industrial ecosystem, towards a more exploratory strategy aimed at supporting the emergence of new industries. Moreover, PoliTo will undertake the following steps:

- Expand the involvement of SMEs: Although some steps have already been undertaken, only a few SMEs are currently collaborating with the university. Since 2014, a more integrated approach has been adopted, and a growing number of initiatives have been implemented. The involvement of such SMEs will continue and expand in the near future, possibly together with the upcoming initiative concerning the Competence Centre (see the last point).
- Formalising technology transfer activities: The structure of TTO is being redesigned in order to strengthen the formal relationships between the PoliTo departments and external actors, as well as a revision of the procedures for IP protection and diffusion. This will favour the transfer of knowledge and technology, especially to SMEs, and will help support them in appropriating returns from collaborative R&D.
- Expanding cross-departmental research centres in collaboration with industry – the creation of cross-department research centres, focused on new 'breakthrough technologies', will be completed in 2018. One of the key challenges will be how to share research infrastructures with both large companies and SMEs in order to allow them to co-evolve in the development of emerging technologies. TTO will be involved in this process, so that this collaborative research can be achieved.
- Increasing the attraction of investments: Activities related to the 'Third Mission' still need further investments in order to maintain the steady growth in the number of filed patents regarding new technologies, the growth in the number of spin-offs and their ability to raise early stage funding from investors and local companies. In this respect, the agreements signed in 2017–2018 with V3,[17] a Venture Capitalist fund that specifically

[17] Vertis Venture 3 Technology Transfer.

targets university TT, represents a first remarkable attempt to attract investments in order to foster technology development and transfer.

- Creation of a new research collaborative space: In June 2018, PoliTo won a competitive national tender, financed by the Italian Minister of Economic Development, for the creation of a 'Competence Centre' focused on key enabling technologies regarding 'Industry 4.0'. Such technologies include the Internet of Things, Big Data, Blockchain, Additive Manufacturing and so on, and their development is aimed at creating a collaborative space with large firms and SMEs, where training and research collaboration in TRLs from 5 to 7 can be performed.

Appendix E: University of Warsaw[1]

Aleksandra Goldys, Anna Dąbrowska, Agnieszka Pugacewicz and Dominik Wasilewski (University of Warsaw, Poland)

E.1 INTRODUCTION OF THE UNIVERSITY AND ITS REGIONAL CONTEXT

The University of Warsaw (UW) is Poland's leading comprehensive university. The university is located in the capital city of Poland – Warsaw, in Mazovia region (in Polish *Mazowsze* or *Mazowieckie*). It is the country's second oldest university, with a history going back two centuries. Some of the UW alumni play a leading role in contemporary Polish politics and culture as well as in the business sector. UW's Alumni Club has over 13 000 members and the number grows every year. Among them are the country's leading computer science professionals, economists, lawyers, politicians, civil servants and business leaders.

The UW is a research university with strong teaching competences and high levels of third mission activities with municipal, regional, national as well as global outreach. Since 2017 UW has been strategically developing an intensified research and education partnership with the neighbouring Medical University of Warsaw. This partnership is expected to transform the cooperation into a federation of the two universities in the near future.

The UW encompasses 21 faculties and over 30 research units. The UW research portfolio covers most traditional scientific disciplines, including natural sciences, social sciences, and humanities. The research potential (measured by the number of academics) is about three times bigger in social sciences and humanities than in natural sciences. During the last 15 years it has been developing a more interdisciplinary strategy, enhancing and stimu-

[1] The (re-)numbering of sections, tables and graphs in this appendix was done by this book's editors, as well as other minor edits to ensure text and format consistency across appendices B to F.

lating cooperation, both among the faculties and with external partners. This involved, among other initiatives and activities, the creation of the Biological and Chemical Research Centre (CNBCh, established in 2013) and The Centre of New Technologies (CeNT, 2013). The creation of these centres was supported by intensive investment programmes financed by the EU and the regional funds to construct dedicated modern facilities. In the social sciences the Centre of Migration Research, the Digital Economy Laboratory and the Social Challenges Unit are just a few examples of the interdisciplinary approach to research units that were established in the last decade.

The developments in infrastructure and intensified internal and external cooperation have been driven by significant increases in budget and in number of UW administrative staff in 2008–2016 (see Table E.1). These changes happened alongside specific demographic trends in Poland when the number of students significantly diminished. As a result, there have been new circumstances that encourage growth in quality of all institutional processes – related to science, education, impact, as well as organisational efficiency.

Table E.1 University of Warsaw: key facts and figures

	2008	2016
Budget (mld PLN)	0.865	1.431
Budget (mld EUR)	0.216	0.360
# staff (FTE)	5 100	6 400
# of research staff (FTE)	3 200	3 300
# students	56 000	47 000
# publications	7 047	8 710
# top 10% publications (and %)	120 (6.7%)[1]	141 (6.3%)[2]

Notes: [1] Measurement time-period: 2007–2010; [2] 2011–2014.

UW ranks in the top 3% of the world's best research universities, according to various rankings (THE, QS and ARWU). It is the best university in Poland and one of the leading universities in Central and Eastern Europe (CEE). The research performance of the University is also reflected in the results of the 2016 Nature Index of Rising Stars. This ranked the University of Warsaw 3rd among the institutions of Southern and Eastern Europe. Globally, it occupied 96th place (out of 8 000 global institutions).[2] The UW is classified in the top 500 universities of the ARWU ranking (Academic Ranking of World Universities

[2] Nature Index 2016 Rising Stars seeks to identify the ascendant performers in the research world, using the power of the Nature Index, which tracks the research of more than 8 000 global institutions, https://www.nature.com/articles/535S49a.

or The Shanghai Ranking). In 2017 UW increased its ARWU ranking by 100 positions, and in 2018 there was a further advancement observed in science: mathematics and physics (see Table E.2). A few other fields also scored relatively high: earth sciences, computer science, and social sciences. However, in the Shanghai Ranking of Academic Subjects 2018, the natural sciences were ranked much higher than other fields of science.

Table E.2 ARWU rankings per field of science

	Rank position	
	2018	2017
Natural Sciences		
Mathematics	51–75	101–150
Physics	51–75	151–200
Chemistry	401–500	301–400
Earth Sciences	401–500	*not ranked*
Engineering		
Computer Science & Engineering	301–400	*not ranked*
Materials Science & Engineering	401–500	301–400
Social Sciences		
Economics	301–400	*not ranked*
Political Sciences	201–300	*not ranked*
Psychology	301–400	*not ranked*

According to QS World Ranking UW (2019) is ranked in 394th place, but in QS University Ranking for Eastern Europe and Central Asia the UW (EECA University Ranking) is ranked sixth (out of 300).[3] In selected fields UW is among the top 150 in mathematics and physics, the top 200 in natural sciences and the top 300 in humanities. Seventeen programmes provided by UW have been listed in QS World University Rankings by Subject 2018, while 15 programmes have been listed in Eduniversal Best Masters & MBA Ranking 2017.

The University of Warsaw is ranked sixth in the new Europe ranking by THE (Times Higher Education) (the ranking included 53 universities from 13 states that have joined the European Union since 2004). The position of the

[3] The countries are divided into nine groups: (1) Asia-Pacific, (2) South East Europe, (3) Middle East & West Asia, (4) South & South East Asia, (5) Africa, (6) Central &South America, (7) East Asia, (8) North America and (9) Western Europe, https://www.topuniversities.com/universities/university-warsaw.

UW in the global ranking (including 1 103 institutions) is between 501 and 600.[4]

UW's research strategy is focused on a harmonious development of all fields of science and to provide stronger support for interdisciplinary undertakings. Interdisciplinarity is becoming more important because diversity is seen as a key to multi-level development and more effective cooperation with external partners, including regional partners.

E.2 REGIONAL ORIENTATION, STRATEGIC DEVELOPMENT, AND KNOWLEDGE INFRASTRUCTURE

According to the Regional Innovation Scoreboard 2017, the Mazovia region is ranked as a moderate innovator with an innovation performance below the EU average but ranked highest among all Polish regions. The innovation performance had been improving in earlier years, however over recent years it has returned to the same level as 2011.

Mazovia region has a well-developed research infrastructure, but the core regional academic activity is concentrated in Warsaw. Here 75% of Mazovian universities are located, which attract as many as 90% of all regional students. In Warsaw, for every 10 000 inhabitants there are 1 366 students (2016). According to QS Best Student Cities 2018, Warsaw was ranked in 53rd place (out of 101 worldwide) in the list of best cities to study.

Bearing in mind the specificity of Warsaw as an international competitor, the University of Warsaw has always been a strategically important vehicle for Warsaw and Mazovia region through:

- Being one of the largest employers in the region, with over 7 300 staff, half of which is academic and the other half administrative;
- As a source of human capital, UW attracts students from all over the country, although on average as many as 60% of candidates come from Mazovia region (2008–2017). According to the national system for graduate tracking 70% of graduates from University of Warsaw remain in Mazovia region (according to the Polish Graduate Tracking System, and based on the first two years after graduation);
- Together with other HEIs in the Mazovian region, UW plays a key role in driving regional smart specialisation in areas such as food safety, intelli-

[4] https://www.timeshighereducation.com/worlduniversityrankings/2018/worldranking#!/page/0/length/1/sort_by/rank/sort_order/asc/cols/stats.

gent management systems, modern business services and high quality of life.

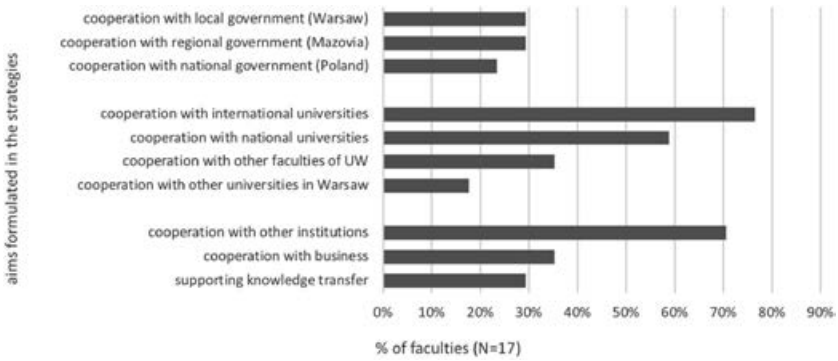
UW's geographical location enables strong relations with national and regional representatives, illustrated by the fact that UW is an important partner in advisory boards, at the municipal and regional levels, dedicated to innovation strategies. Comparing the regional-specific vision with the occurrence of other strategic goals (e.g. the development of curricula or research-oriented aims) the former sometimes is seen as less important. Academic cooperation at the international level seems to be more viable than relations with local or regional institutions. This approach goes in parallel with business strategies in Warsaw. A highly networked city (known as the one and only 'world city' in Poland) is a business hub for many globally oriented trans-national companies. The strategies of these firms are focused more on the national or world market, rather than regional needs. This might cause a rational obstacle for fostering regional innovation and sometimes the regional perspective is missing.

In spite of this, we can observe two trends in Poland regarding the role of universities: they are expected to be more engaged in the society and regional innovation systems; their mission statements are rapidly evolving and have become increasingly important in the public debate. However, the university's career reward systems do not yet recognise entrepreneurial and engaged research, teaching, and co-creation.

The UW's longer-term strategy, and supporting strategies of the faculties, focus on the need for cooperation between the university and other partners. One of UW's main goals is strong and well-developed relationships with the region, which enable the university to influence the society and to react accordingly to the needs formulated by the region. In the UW's mid-term strategy (2014–2018) the fourth goal is directly dedicated to the relations with external partners (i.e. the city of Warsaw and the region) and professional knowledge transfer.

Also, in the strategic documents of the individual faculties there are statements about the cooperation with administration in the city of Warsaw, the Mazovia region, as well as the national government. However, those statements are formulated only by every third faculty of the university (see Figure E.1). Several of those faculties – like computer science, physics, biology and political science – have become fairly entrepreneurial in their own right. For example, the dean of the Faculty of Geography and Regional Studies established a special advisory role for an academic entrepreneurship professor to support both entrepreneurship education and stronger connections between the faculty and its external partners.

As for UW's 'regional smart specialisations' profile, the most active UW units were those from the Natural Sciences, but representatives of Social



Source: Zieliński J. 2017, Relacje nauki i administracji w europejskiej metropolii. Przykład Uniwersytetu Warszawskiego i Urzędu M. St. Warszawy, master thesis (supervisor: Wojciech Dziemianowicz), unpublished, Faculty of Geography and Regional Studies, University of Warsaw, p. 5.

Figure E.1 Share of UW faculties that express regional-specific goals vs. other goals in their strategies

Science and Humanities also actively participate. For example, the UW experts were involved in creating the main strategic document for local authorities of Warsaw – Warsaw's Development Strategy 2030. Together with municipal officials the UW experts (in regional development, geography, economics and sociology) co-created a broad-scale inclusive process that produced recommendations for the city of Warsaw's future development. The UW Rector is invited in the Mazovia and Warsaw Innovation Councils that initiate strategic decisions in a regional innovation ecosystem. In 2017, UW and the city of Warsaw signed a memorandum of understanding to facilitate a closer cooperation (actually the cooperation already existed a long time before the agreement) with the aim of building a long-term multifaceted relationship between the two institutions. The agreement encompasses, among others, facilitating public internships for UW students, contracting more research, and increasing MA and PhD theses in the programme 'Warsaw Diplomas'. There is also a new project 'Initiative: Academic Warsaw' which aims to support informal contacts and networking solutions for both parties.

E.3 EDUCATION AND HUMAN RESOURCES DEVELOPMENT

The University of Warsaw attracts its students from all over the country. However, the majority (60%) of the student applicants come from the

Mazowieckie region. For years, the majority of UW applicants declared the UW was the only university they applied for or was the most highly preferred. In the previous ten years the share of students from the capital city region ranged from 58% (2014) to 69% (2008).

UW currently has a total of more than 44 000 students in its first cycle (bachelor's) and second cycle (master's) degree programmes. Full time students constitute 70% of the total number. The number of PhD candidates equals 3 200 and it has grown by 25% in last few years, strengthening the UW academic staff numbers. Nearly 250 doctoral degrees are awarded each year. There are also 4 000 students following postgraduate programmes with a choice from nearly 150 subjects.

A growing number of students come from abroad. Nearly 1 600 foreign students attend full-time courses. Over the past ten years, the percentage of international students has grown 2.5 times. In 2017 there were nearly 2 500 candidates (7.2% of total number of applications), mostly from Ukraine (28%) and Belarus (22.5%). In comparison, in 2008 there were only 600 candidates (1.6% of all candidates, with 26% from Belarus and 14% from Ukraine). The number of PhD candidates from abroad now accounts for 9.3% of the total. The University of Warsaw offers also short-term programmes, for example lasting one or two semesters (Bilateral agreements, Erasmus+ Programme, Visiting Student Programme, Governmental agreements, and state programmes).

The students are offered a broad range of courses in the fields of humanities, social sciences, and natural sciences. Interdisciplinary courses have become more and more popular over recent years. Students of first and second cycles can choose between over 100 programmes in Polish, 26 programmes in English, and 29 double degree programmes run by UW and international partners. For doctoral students 35 programmes are offered in Polish and individual PhD programmes are offered in English. These PhD researchers are further supported with professional development: in 2010–2014 regional PhD scholarships (54 PhD candidates) and professional trainings (200 participants) during the 'Doctorates for Mazovia' programme were offered. A new form of doctorate – an industrial doctorate – has recently been introduced at UW in the Faculty of Chemistry and the Faculty of Physics.

The high quality of teaching at the University of Warsaw is confirmed by various rankings. The University of Warsaw holds very good positions in comparative evaluations of the quality of education. Seventeen UW programmes have been listed in QS World University Rankings by Subject 2018 and a further 15 programmes have been included in Eduniversal Best Masters & MBA Ranking 2017. The quality of education is confirmed by the annual surveys conducted by the university itself which show that the majority of students are satisfied with their choice of the university and the education programme.

According to an advanced national system for graduate tracking, on average (2017–2018) 80% of the graduates from the University in Warsaw remain in the Mazovia region. Warsaw is therefore not only an interesting place for studying, but also a very attractive and competitive labour market for young people. According to the results of the monitoring 94% of former students from University of Warsaw find employment within a year of graduation, of which 55% were employed with permanent contracts. The average earnings of UW alumni reached nearly 80% of the average salaries in their respective residential region.[5]

The UW strategy considers the needs of the innovation ecosystem for co-developing education programmes to build a modern portfolio of degrees. Most faculties of the UW involve regional private, public and non-governmental sector stakeholders in the design and evaluation of their study curricula. With the new HEI law in Poland the coordination of the education portfolio will be shifted from the faculties to the central level. It will also be strategically supported by the new council of the university, in which half of the members represent external institutions. The interaction with local firms is already established both through research within the consortia and entrepreneurship education provided by external instructors. Every UW undergraduate student must complete at least 120 hours of internship at the local company or institution.

The developmental grants provided by the Polish National Centre of Research and Development (NCBR) provide opportunities for social innovation oriented topics, where UW students develop interdisciplinary master theses that address specific problems related to sustainable development. The Innovative Humanistics (InnoHuman) programme supports theses prepared by master students in various faculties: Faculty of Journalism, Information and Book Studies, Faculty of Political Science and International Studies, Faculty of Philosophy and Sociology, Faculty of Polish Studies, Faculty of Psychology and Faculty of 'Artes Liberals'.

The 'ZIP – University of Warsaw integrated development programme', the newest PLN 40 million grant that started in 2018, covers high quality education, including 'Research Based Learning' (RBL courses are 'Service Learning–Societal Challenges' and 'Urban Lab'), entrepreneurial co-curricular competences, and modern UW management processes development.

[5] Source: ELA, 2018 https://ela.nauka.gov.pl/en/labor-market/earnings_and_regions_poland.

E.4 RESEARCH, TECHNOLOGICAL DEVELOPMENT AND KNOWLEDGE TRANSFER

The University of Warsaw builds strategic alliances in order to enhance the quality of research. In 2017 it started cooperating within '4EU+', a pan-European alliance among UW, University of Sorbonne, University of Heidelberg, Charles University, University of Milan and University of Copenhagen. The 4EU+ alliance was selected as a 'European University' in the framework of the Erasmus+ programme (out of 54 applications 17 were selected). The university also belongs to more than 100 global research networks and various consortiums set up to conduct research projects. In many fields, UW research groups maintain a well-established position in the academic world.

A focus on closer regional research capacity enhancement has been implemented through multi-level (research, education, management) cooperation agreement with the Medical University of Warsaw that might lead to future federation of both HEIs. The University of Warsaw also embarks on multilateral regional cooperation within regional clusters. The faculties and the researchers engage in cluster cyclical meetings with the purpose of setting up consortia for new project opportunities. These consortia in which UW is usually a partner make use of the most developed science laboratory infrastructure in Poland, located at UW Ochota Campus.

UW is also a Core Partner in EIT Food consortium with a budget of €3.5 million in 2018. This research and action partnership consists of 50 European business, NGO and academia institutions. In 2018 12 common projects were established, where UW is a leader or a partner, including: EIT Food Government Executive Academy, Trust Barometer, EIT Food RIS Fellowships, SmartFoodLogging (SFL), EIT Food Summer School on New Product Development, Games of Food, Global Food Venture Program, Food System Master of Science Programme, X-KIC RIS Project. Warsaw hosts the so-called Co-Location Centre – CLC North-East.

The state-of-the-art equipment and facilities significantly support research, such as modern research laboratories, computer networks, multimedia technologies and advanced computer programming. The modernisation in life sciences was financed from the European Union's structural and investment funds. The biggest investments during this time were: the Biological and Chemical Research Centre (new technologies in the fields of energetics, analytics, pharmaceuticals, medicine, biotechnology, new materials, environmental conservation and cultural heritage), Centre of New Technologies (research developed in biology, chemistry, physics and information technologies) and the Centre for Preclinical Research and Technology (new medicines and their

applications). In November 2015 a multi-annual development plan for the University of Warsaw (for 2016–2025) was adopted by the Polish government. Circa €230 million devoted to this programme will allow UW to develop infrastructure for transdisciplinary research centres engaged in humanities and social sciences. The infrastructure and UW R&D facilities (laboratories) as well as co-work in UW office space will also be used by the local community partners.

UW serves as a competent opinion maker that provides informed solutions for global challenges. UW staff were the first foreign archaeologists to participate in the rescue of monuments from the ruins of the Syrian Palmyra – just a few days after recapturing the city from Islamic State.

Since the establishment of the NCBR the University of Warsaw accelerates cooperation programmes with business and non-governmental partners. Annually, there are around 50 projects with a total value of PLN 16 million (€3.7 million, 2016). These programmes include broad areas of science like graphene applications, development of modern management tools, tests of high temperature reactors for industrial applications, image recognition and others. UW usually plays a role of research contractor.

The University of Warsaw attracts about PLN 200 million annually from external services, where 50% is acquired by continuous and professional education and the other half from contract research and professional services. The contract research services have been vastly developed at the UW in the last few years. Among the expert centres and laboratories whose services are directed to external institutions, the special interdisciplinary Centre for Forensic Science was established, which carries out forensic examinations, and provides professional statements and opinions, for example in the field of identifying perpetrators of crime and document falsification. The Biological and Chemical Research Centre and their accredited centres ('Analytical Expert Centre', 'The Laboratory of Environmental Chemistry', and 'The Laboratory of Structural, and Physical and Chemical Research') offer specialised services in biogeochemistry, environmental protection, and physic-chemical services and commissioned tests of substances, concentrations of selected metals in water, soil, food and cosmetics.

The contract research development in social sciences at UW progressed significantly at the end of 2013, when Google funded a US$1 million grant to establish the interdisciplinary Digital Economy Laboratory (DELab). So far Google has funded such research institutes only at Stanford University, Oxford University and Humboldt University. For CEE, DELab UW became the main hub for intensive research of digital technologies and their impact on the economy and society. Another Social Challenges Unit offers contract research in health, well-being, sport and ageing population issues. In political science the external research services are provided by the Centre for Political

Analysis, which prepares commissioned reports, writes expert opinions, and offers consulting on modern political issues.

For twenty years, UW has been involved in direct and indirect technology transfer processes. The University of Warsaw Technology Transfer Centre (which goes by the Polish acronym UOTT) provides professional services for intellectual property protection. UOTT offers support for the UW academics with patent issuing, licence granting or sale of rights. It also provides contacts and programmes for government or private funding and professional advice on academic IP protection. In 2016, The Polish Patent Office granted UW with four patents and 30 patents have been covered by international patent protection. The total turnover of UOTT in 2016 was PLN 30 million. A large part of research in the newest Centres of New Technologies (CeNT) and the Centre for Biological and Chemical Research has been transferred to regional and global biotechnology and pharmaceutical companies. There are over 30 laboratories in CeNT operating in the several scientific fields: biology, biomedical, chemistry, ecology and evolution, physics. "CeNT scientists tackle fundamental scientific problems as well as collaborate on the translation and application of knowledge to industry."[6] The most valuable (US$600 million, 2015–2016) Polish commercialisation through licensing was for mRNA synthesis, which is useful in genetic illnesses therapy.

E.5 ENTERPRISE DEVELOPMENT AND ENTREPRENEURSHIP

Contract research and technology transfer created by university scientists was considered the most crucial source of enterprise development. This was the main reason why UW's UOTT (University Technology Transfer Office) was established almost twenty years ago. UOTT redirects patent commercialisation and spin-off companies to UWRC Sp.z.o.o. (a special purpose vehicle company established in 2012). The first spin-off was co-founded in 2014. Since then, eight spin-offs emerged with their main focus on biology, genetics and radiopharmaceuticals. There are also data-science oriented spin-offs (MIM-Solutions, Spektrino). In 2018 five new companies were co-founded by UW: CRI (Centre of Information Refinery) for big data analyses, Matariki Bioscience company cofounded by Polish Academy of Science in a drug-discovery model for biotechnology. In November 2018 a Microanalysis for hemodialysis was spun out by the Faculty of Chemistry. GeoLearning and another data science project called Project42 emerged at the end of 2018.

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[6] https://cent.uw.edu.pl/en/cent/.

Since 2015 UOTT also orchestrates a multi-sided cooperation through a dedicated digital database 'UW Offer', where both the researchers and the business or public partners provide their research services or research demand, respectively (now some 200 items are registered). Direct science–business cooperation is developed through monthly meetings in the Innovation Club. The main topic of the meeting is pre-defined and special invitations are sent to the companies and scientists. The meetings are held in an informal atmosphere and provide not only knowledge exchange but specialised networking.

The University of Warsaw enables knowledge exchange with regional companies and NGOs also through space sharing. The partners make use of UW's R&D facilities (laboratories) as well as co-work in UW office space. The income generated from the business R&D sector located in the Biological and Chemical Research Centre (2015–2018) equalled PLN 3m. With the establishment of the Digital Economy Lab, in 2014 a special Action Zone for university teams and private companies and NGOs was opened in a modern University Library (BUW). This cooperation enabled both R&D capacity development (for example effective applications for Horizon 2020 grants) and co-creation of entrepreneurship education programmes (including special programmes for female students). In 2018 the space was transferred to UW Incubator with further science–business co-working focus and development of social entrepreneurship space for students.

In recent years UW has developed a new perspective on what is needed in enhancing entrepreneurial culture and context: more focus on the innovative ecosystem, social dimensions, sustainable goals and paying more attention to entrepreneurial skills.[7] UW has now secured a series of support facilities for enterprise development at all stages of the process, from building an entrepreneurial mind-set among students and staff to spin-off company establishment. The three UW pillars are:

- Education – both at a very basic level to be accessible for all students from all UW departments and more specific support to be helpful for more developed projects and ideas;
- Mentoring – which despite obvious one-to-one contact, brings a valuable network of experts from business and public sectors into university;

[7] It is worthwhile to point out here cultural and semantic differences in Poland (and the Polish language) towards the word 'enterprise' which is understood only in a business sense – not universal and broad as a process of creating different models that enable change in a sustainable way. Another limitation in thinking of entrepreneurial efforts driven by UW (in general but in this case especially) comes from associating them with science only – equating entrepreneurship with technology. That effectively has excluded humanities and social science from UW's entrepreneurial endeavours.

- Space – universally open and attractive spaces at all three campuses to be used by UW students, enterprises, and partners.

UW's Technology Transfer Centre also launched a new organisational vehicle – UW Incubator (IUW) – fully dedicated to supporting entrepreneurial skills among students and alumni as well as accommodating entrepreneurial ideas of staff. IUW facilitates meetings and workshops dedicated to MedTech, BioTech, social programmes or IT. Priority is given to interdisciplinary programmes supported by knowledge of experts from outside the UW that share their knowledge and practical experience. This is also much needed to tackle specific problems of the traditional universities being separated from the outside world (one of the greatest obstacles in developing innovations and entrepreneurial approach at Polish HEIs). An interesting example of such a specific event organised by IUW is the MatchIT start-up-like weekend. This educational event integrates computer science students (the IT institute belongs to one of the strongest faculties of UW: Faculty of Mathematics, Informatic and Mechanics) with students from all other fields. They work in multidisciplinary teams during a work-intensive weekend-long idea challenge to produce and pitch valuable services based on digital solutions.

In its first year of operation the IUW has attracted 2 100 students participating regularly in the wide range of workshops and trainings. A network of faculty ambassadors was created for 21 departments and almost 100 mentors were invited to support students' ideas. The IUW was also one of the first units that launched cooperation with the Medical University of Warsaw (which is a separate neighbour university) and the Academy of Fine Arts (follow the need to strive for more design-based innovative projects). Interesting applied projects based on strong cooperation with companies have happened before in several departments – like in the case of the Faculty of Modern Languages cooperating with Seitel and Samsung, but now they can be strategically supported from the university as a whole.

To intensify the cooperation within all university departments and with the external partners, the Faculty of Management established the Centre for Entrepreneurship. It serves as a research centre that provides advanced analyses in the field of entrepreneurship, fosters entrepreneurial education together with other faculties and UW units, and promotes research cooperation with business partners. The Centre hosts the annual international conference on 'Entrepreneurship for the XXI Century – Images and Perspectives' that gathers both business and academic communities. This Centre also created a special annual award for entrepreneurs in five categories to promote those alumni who successfully created and developed businesses, including social business.

Entrepreneurial projects also emerged from UW's central office, such as the InnoHuman project that is fully dedicated to masters' theses and support for

those students who want to implement their research results. This project was followed by 'E-co-solving' in which the students' research was based on the needs specified by business and public partners. The results from this project, together with experience from DELab, UOTT and other university teams, provided a platform for coordinated, cross-departmental cooperation within UW under the flag of 'Integrated Entrepreneurship'.

When defining the entrepreneurship in a broad way – as a platform of enabling cross-sectoral actions making change in the whole internal/city/regional and (inter)national context – UW is playing a significant role as a public investor. For ten years UW has been applying for regional and EU funds, as well as governmental grants to develop the infrastructure. Changing the city of Warsaw's landscape with academic facilities becoming more open to the public, engaging companies from the construction industry and hiring the best architects to create multifunctional places can be described as a modern organisation of the city and regional infrastructure.

In the coming years UW will invest around PLN 1 000 million in its several buildings to accommodate business oriented co-working and co-creation spaces, with a dedicated space for common usage among the local community, public and private partners to foster entrepreneurial cooperation. Supporting office-space infrastructures will be established to conduct complex investment processes, all in close cooperation with the municipality as well as the internal and external communities.

E.6 VISION AND STRATEGY FOR THE NEAR FUTURE

The University of Warsaw's strategic plan provides a vision focused on better utilisation of its innovation potential within the regional context:

- To develop a comprehensive education programme with a large number of well-chosen fields of study and scientific research that responds to local needs (labour market, innovative economy and civil society), with a focus on smart specialisations within the Mazovia region.
- To concentrate on flagship research projects that consist of interdisciplinary teams, strong business and local government contribution and responding to the main global challenges (such as the Knowledge Innovation Centre project 'Food for the Future').
- To participate strongly in all regional and national efforts in creating stable innovation ecosystems, where the role of UW is crucial.
- To develop proper financing of all mission activities and to increase the ability to raise funds from various sources within a changing perspective of

EU structural funding and a new higher education law in Poland (effective in Autumn 2018).

- To further build on the impact of UOTT, UWRC, Incubator and other third mission units in adjusting patenting and incubation services, contract research, entrepreneurial education, and nourish regional relationships to offer a professional portfolio of research services, quality and engaged education, as well as multilateral (academia–business–NGO–public) cooperation opportunities.
- To create conditions for cooperation with students, as well as to seek to professionally engage with alumni both in Poland and abroad, with a focus on the Polish community in the US, where *American Friends of UW Association* has been recently established.
- To offer adequate and professional institutional supporting services, including innovation-oriented facilities and infrastructure as well as modern management and administration services, dedicated to the internal academic community and the university's external partners.
- To continuously advance in international rankings through further synergy of sciences, including a federation with the Medical University of Warsaw, internal supporting grants for valuable research projects and consortia creation, to attract both local and international candidates and develop a vital multinational exchange of knowledge and human capital.

Appendix F: Rovira i Virgili University[1]

Aleyois Pilar Haro Peralta, Ignasi Salvadó Estivill and Francesc Xavier Grau Vidal (Rovira i Virgili University, Spain)

F.1 INTRODUCTION OF THE UNIVERSITY AND ITS REGIONAL CONTEXT

The Rovira i Virgili University (URV) is on the south Mediterranean coast of Catalonia, about one hundred kilometres from Barcelona. URV has developed a multi-centre structure with its main campuses in Tarragona and Reus. Created in 1991, the URV is a young, civic university engaged with its region, Southern Catalonia, which is made up of the Camp de Tarragona and Terres de l'Ebre. Since its beginnings, the URV has adopted a dispersed campus model that has facilitated its connection with the network of cities in the province of Tarragona.

The URV has taken advantage of a region in which each area has had a line of economic specialisation spanning recent decades. Research and educational centres have exploited this specialisation to find links with companies. Hence, URV has defined its own areas of specialisation in alignment with the socio-economic strengths of the region so as to project the University internationally as a research university and at the same time contribute to the development of the region. The URV is the only public university of Southern Catalonia and its main source of funding is the Government of Catalonia.[2]

Since 2001, the URV has built up a network of six public research centres, four technology centres, four university hospitals and various business associations that have close connections to the areas of specialisation. This network has been awarded the status of Campus of International Excellence Southern

[1] The (re-)numbering of sections, tables and graphs in this appendix was done by this book's editors, as well as other minor edits to ensure text and format consistency across appendices B to F.

[2] It should be noted that in its funding formula the regional government does not consider regional impact indicators but rather promotes education quality.

Catalonia (CEICS) by the Spanish Ministry of Science, and facilitates the interaction between the university, the research and technological centres, and the manufacturing sector. It offers prestigious training, with special emphasis on postgraduate studies in priority areas and provides an excellent research environment in which companies can develop their own projects, create synergies, and eventually become more competitive. The specialisation areas of the CEICS and the URV are: chemistry, energy and new materials; nutrition and health; oenology, tourism, heritage and culture; and ICT and digital economy. They are all part of the Research Innovation Strategy for the Smart Specialisation of Catalonia (RIS3CAT) defined at the level of Catalonia (NUTS2). Catalonia is classified as a moderate innovator in the Regional Innovation Scoreboard.

Table F.1 URV: key facts and figures

	2007	2017
Budget	€108.6M	€103.2M
Teaching and research staff (FTE)	962	1 005
Research staff (FTE)	125	141
Administration and services staff (FTE)	566	704
Students	12 473	13 756
Publications	552	1 313

This vision and the corresponding leadership have led to the development of world-class teaching and research, which has placed the URV in prominent positions in global rankings, despite its youth and regional character. In 2018, it was the World's 80th Best Young University, and has been included in position 401–500 in the Global World University Rankings (both by the Times Higher Education World University Rankings) and it was ranked 268th in the CTWS Leiden Ranking 2017 (top 50%). The URV is also one of the best 500 universities in the Shanghai Ranking's Global Ranking of Academic Subjects 2018 in 14 different subjects. Table F.1 presents selected performance statistics for 2007 and 2017.

As befits the Triple Helix model, the URV has strong ties with regional politicians (municipalities and the Provincial Council). In fact, the main cities and the Provincial Council have formed a Core Driving Group (CDG), coordinated by the URV Chair for University and the Knowledge Region, in order to develop a suitable system of governance and improve the regional innovation system. Their most important challenge is to transfer the regional policy competences to the NUTS3 level. By benchmarking with all Western EU countries, it is clear that the larger-than-normal dimensions of Catalonia and Tarragona

limit the application of the subsidiarity principle. This makes the European regional policy in Catalonia less effective and/or less efficient.[3]

F.2 REGIONAL ORIENTATION, STRATEGIC DEVELOPMENT, AND KNOWLEDGE INFRASTRUCTURE

At the beginning of the 2000s the URV took a series of strategic decisions which have been largely responsible for the subsequent successful development of the university and of the knowledge and innovation ecosystem in which it is now a key player. This has been recognised by the regional government and industry. Consequently, there has been a high degree of cooperation between the URV, the governments of Catalonia and Spain (through their respective competitive programmes) and the principal companies and local administration in the region (see Figure F.1).

In this context, and in response to a call from the national government, CEICS was initially recognised in 2010 and got the final stamp of approval in 2015. The CEICS, led by the URV, is the primary instrument for the governance and coordination of the Southern Catalonia Knowledge and Innovation Ecosystem. An essential aspect of the CEICS has been the positioning of territorial specialisation in the education, research, and innovation triangle, which among many other aspects is very important for the participation of Southern Catalonia and their agents in the RIS3CAT.

As a sign of its commitment to the region, the URV approved its first 'Third Mission Strategic Plan' in 2009. This plan has increased the visibility of URV outreach and reinforced its commitment with institutions, companies, social agents and society at large. In addition to the hard knowledge infrastructure mentioned above, the URV has developed a range of different elements to give further support to research and innovation. Among others, these are:

- A network of 'Knowledge and Innovation Antennas' throughout the region's 13 municipalities engages in cultural programming and the dissemination of science, knowledge and innovation. In 2016, the antennas conducted 225 activities in which 10 000 people participated.
- The URV's Chairs act as forums for disseminating the specialised research and training activities carried out by the URV in collaboration with public and private entities. In 2016 they received external funding of €580 000 as

[3] For more information: Grau, F. (2016), Southern Catalonia Knowledge Region, Publicacions URV (http://www.regio-coneixement.catedra.urv.cat/media/upload/domain_697/arxius/Grau%252c%20X.%20-%20Southern%20Catalonia%20Knowledge%20Region%20-%202016.pdf).

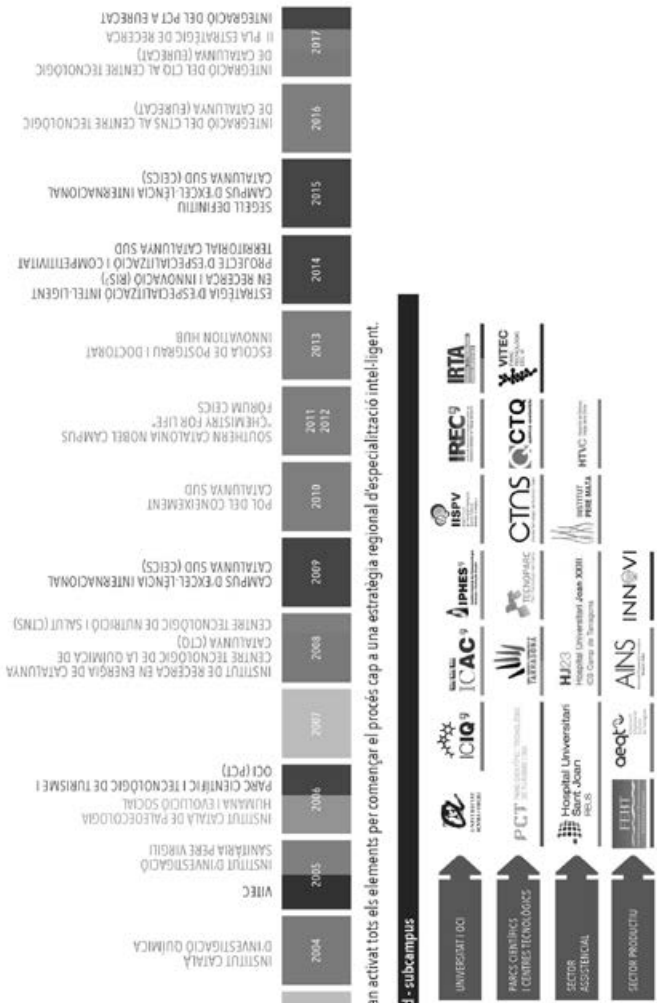

Figure F.1 Knowledge infrastructure strategy

well as the additional resources that they earn from their own projects. The Chairs build strong relations between the URV and all the agents operating in the region. They also show that efficient interactions and trust can be generated between society and the university, thus making creative reflection and essential debate possible.

- The Tarragona Knowledge Region Office is a joint project between the URV and the Tarragona Provincial Council that encourages the innovation and competitiveness of the companies in the region. In 2016, 12 projects were granted a total of €5.2 million.
- The Southern Catalonia International Conference Centre is also a joint project with the Tarragona Provincial Council. It offers a comprehensive service for the organisation of conferences and seminars, especially for companies and institutions in the region engaged in research, teaching and knowledge transfer through the URV and the CEICS. In 2017, it gave support to 14 conferences with a total of 1 745 participants.

F.3 EDUCATION AND HUMAN RESOURCES DEVELOPMENT

The Southern Catalonia region is characterised by a business environment with an entrepreneurial tradition that has coexisted with the emergence of large multinationals. The combination of these two factors has created a set of small businesses that coexist alongside large companies with a considerable capacity for investing in leading research. Thus, SMEs take advantage of the existing human capital in the region. Accordingly, the URV aims to develop a range of quality bachelor degrees, in practically all knowledge fields and adapted to the regional socio-economic situations. Table F.2 provides a summary overview of the URV performance on education and human capital development.

Table F.2 Overview of URV performance on education and human capital development

Indicator	2013	2017
Number of bachelor degrees offered	45	50
Number of bachelor degree students	11,773	11,138
Number of bachelor degree students first year	3,141	2,851
% Students bachelor degree from Tarragona Region	73%	67%
% Students masters from Tarragona Region	53%	44%
% Students doctorate from Tarragona Region	46%	39%
Number of industrial doctorates	6	16
Number of industrial doctorates finished	0	10

Indicator	2013	2017
Number of students attending internship	1,809	2,497
% students where the internship was with a company or organisation located in the region	15%	22%
% graduates' satisfaction about choice of bachelor degree	n/a	73%
% graduates' satisfaction about URV	n/a	69%
% graduates working in Catalonia after graduation	n/a	75%
% population aged 30–34 having completed tertiary education	35%	41%
Number of lifelong learning courses	127	147
Number of students lifelong learning	3,816	4,348
% population aged 25–64 participating in lifelong learning	11%	9%

The bachelor degrees mainly target the citizens of Tarragona province, which is where 67% of the students originate. Three years after graduation their employment rate is around 86%, most of whom (75%) find work in Catalonia. On the other hand, master's degree and doctoral studies are more oriented towards research excellence of regional relevance. The URV aims to integrate its academic research activities more closely with the educational curricula.

In the Service Learning Programme professors and students undertake activities and projects in collaboration with entities from the region, as part of degree subjects and with the aim of improving the environment. The main objective of the programme is to supplement content learning, skills, and abilities with training socially responsible professionals and developing civic and social commitment through reflective practice. The reflective practice is a technique which is oriented to self-observation and self-evaluation of one or more actions in order to make connections between personal experience and existing theory or models. The programme has a big impact on education as it allows university students to develop their social involvement with the territory, while carrying out their studies. In 2017, almost 900 students participated in the programme – an increase of 220% compared to 2013.

Since 2012, the URV has participated in the Industrial Doctorates Plan of the Government of Catalonia in collaboration with public and private universities, which aims to contribute to the competitiveness and internationalisation of companies throughout Catalonia, retain talent and place doctoral students in companies where they can undertake RDI projects. An essential element of the Industrial Doctorate Plan is a strategic research project carried out in a company that allows the doctoral students to further develop their research training in collaboration with a university. So far, the URV has participated in 22 industrial PhDs, of which ten have already been completed. The main field

of these doctoral theses is nanoscience, materials, and chemical engineering, one of the five territorial specialisations.

The URV has a considerable impact on the education of the resident population. Currently, 41% of the population between 30 and 34 years old has completed a higher education programme. This contributes positively to the competitiveness of the business environment by providing human capital with advanced skills. It has also set up a Lifelong Learning Centre which provides citizens, professionals, and companies with a wide range of lifelong learning programmes that encourage knowledge extension, retraining and professional specialisation. During 2017 it offered 147 courses, 90 of which were directly requested by companies. They were attended by 4 348 students.

One of the projects carried out by the Chair for University and Knowledge Region (CUKR) is the CATSUD-scorecard which is inspired by the EU Regional Innovation Scoreboard (RIS). The 18 RIS indicators are replicated at NUTS3 level. This project allows a comparison of the performance of the CATSUD region with other EU regions. Of the two human resources indicators of RIS, Tarragona is performing well in tertiary education but needs to improve its lifelong learning results.[4]

F.4 RESEARCH, TECHNOLOGICAL DEVELOPMENT, AND KNOWLEDGE TRANSFER

This vision and the corresponding leadership have led to top-quality teaching and research, which, in turn, has resulted in the URV occupying prominent positions in global rankings, despite its youth and regional nature. In 2018, it was 80th in the Young University Rankings, between 401 and 500 in the Global World University Rankings (both by the Times Higher Education World University Rankings) and 268th in the CTWS Leiden Ranking 2017 (top 50%). Recently, the URV has been ranked among the best universities in the world in 14 of the 54 disciplines analysed by the ARWU Ranking's Global Ranking of Academic Subjects 2018. According to the 2017 edition, four more subjects are in the top 500 and, one of them, food science, is in the top 100. It was in position 151–200 for geography and 201–300 for chemical engineering, electrical and electronic engineering, and instruments science and technology. Additionally, in the 2018 QS World University Rankings by Subject the URV was ranked for the first time in position 401–450 for chemistry.

[4] The two performance indicators are: percentage population aged 30–34 having completed tertiary education: 0.60 (EU average: 0.52); percentage population aged 25–64 participating in lifelong learning: 0.38 (EU average: 0.45).

The URV wants to maximise its social, economic and cultural impact through research and innovation based on scientific excellence, the impact of which can also be measured, and thus contribute to the challenges facing society and reinforce the specialised productive sectors in the region. For this reason, in 2017 the URV approved its second Strategic Plan for Research and Innovation. Its main objective is a commitment to quality interdisciplinary research that reaches society, attracts talent and external funding, and is internationally recognised (see Figure F.2). One of the most important of these projects is the MSCA-Cofund DP Doctoral programmes with the main objective to attract talent to the university.

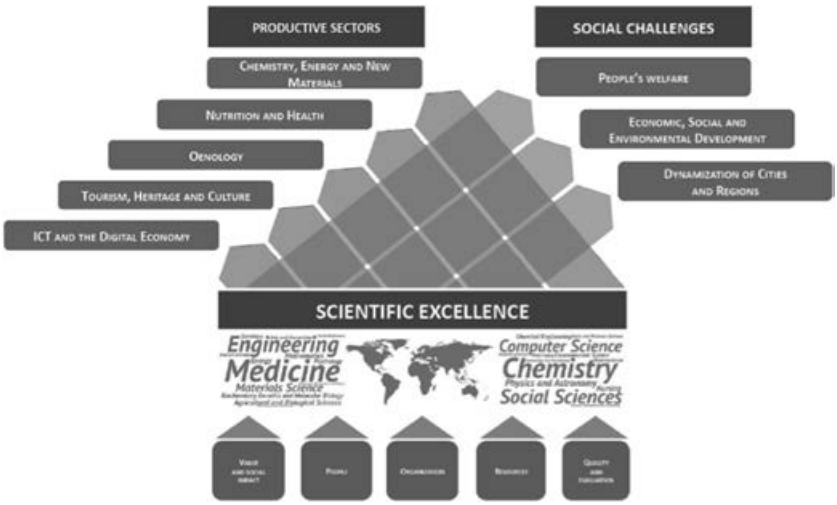

Figure F.2 Second strategic plan for research and innovation

This increase in scientific quality has led the URV to win 187 European competitive projects in the last ten years, with a total value of more than €32 million. In 1999 the URV created the Technology Transfer Office and Innovation (CTTI) centre aimed at transfer technology and knowledge from the URV to the market. In 2017, the CTTI managed 64% of the non-competitive projects mentioned above. In the same year CTTI applied for 24 patents and received €30 000 from the licences of its existing patent portfolio. Table F.3 provides a summary overview of URV's activities and achievements regarding research, technological innovation, and knowledge transfer.

Table F.3 Overview of URV performance on research, technological development and knowledge transfer

Indicator	2007	2017
Total incomes from R&D	n/a	14,400,00
Competitive funds	n/a	7,700,000
National competitive funds	*n/a*	*5,173,150.19*
International competitive funds	*n/a*	*2,526,849.81*
No competitive funds (contracts research and consultancy)	*n/a*	*6,700,000*
Incomes (R&D) managing by CTTI (no competitive funds)	n/a	*4,315,734*
Strategic research partnerships in the region	3	7
Regional partnerships of the Tech Transfer Office	1	4
No. patents applied	3	24
Licensing income from local/regional industry	0	11,255
Licensing income from companies (local and international)	0	29,849
Shared R&D facilities with local/regional industry	18	71
No. publications URV	552	1,313
Public private co-publications	28	126

In 2017 the URV achieved €12.9 million from external R&D funding, of which 47% came from consultancy and contract research for industry and public institutions, approximately 36% from national project funding and the remaining 18% from foreign sources, mainly the European Research Framework Programme (Horizon 2020). The URV has won 187 European competitive projects in the last 10 years with a value of more than €32 million. One of the most important of these projects is the MSCA-Cofund DP Doctoral programmes whose main objective is to attract talent.

In addition of the knowledge infrastructure mentioned above, the Campus Scientific-Technological Resources Service (SRCT) is a joint infrastructure between the URV and CEICS institutions. The SRCT currently has three main areas of activity: Sustainable Chemistry and Renewable Energies; Omic Sciences (Molecular Biology) and Microscopy and Nanotechnology. With an area of 1 500 m^2 SRCT provides scientific support to more than 70 business and other external institutions with a turnover of €660 000.

F.5 ENTERPRISE DEVELOPMENT AND ENTREPRENEURSHIP

Throughout its history, the university has promoted the creation of URV spin-off companies, with the participation of professors and young researchers, aimed at encouraging creativity and entrepreneurship. In 1998 the URV

generated its first spin-off, and since then 24 more companies have been set up, of which 15 are still active. These start-up and spin-off companies directly employ around 100 people and have generated a turnover of almost €15 million over the last ten years (Figure F.3). In 2017 the number of spin-off firms increased considerably, raising more than €2 million of private funding.

URV has played an important role in establishing science parks, in conjunction with local and regional governments. These science parks and related infrastructures, which offer equipment, services and incubators to develop new firms, have helped to create thematic clusters, particularly in the areas of specialisation: namely, in chemistry; food and nutrition; mental health and technology. Besides this hard infrastructure which accommodates some of the region's technological and innovative firms, the URV has also developed some soft infrastructures to give support to and encourage student entrepreneurs. Worthy of particular mention is URV Entrepreneurship, a unit created by the URV in 2012 that coordinates the activities in the field of entrepreneurship in the region and includes the Chair for the Promotion of Entrepreneurship and Creation of Businesses and the Valorisation Unit (UV-URV).[5] The UV-URV is an integrated unit active in technology transfer (CTTI), intellectual property, support to entrepreneurs within the university community, and funding. This platform is made up of 29 regional entities and offers advice to entrepreneurs in all phases of business creation.

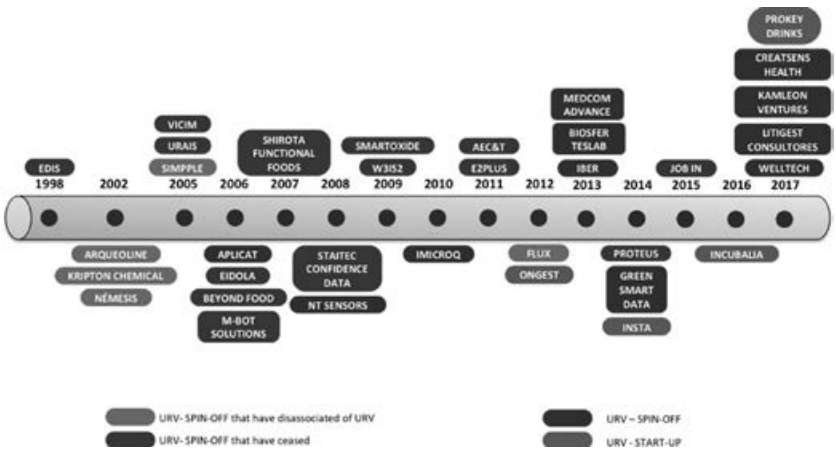

Figure F.3 *Creation and evolution of URV spin-off and start-up companies*

[5] http://www.fundacio.urv.cat/en/technology-transfer/urv-empren/.

F.6 VISION AND STRATEGY FOR THE NEAR FUTURE

The URV aspires to be one of the key institutions in the emergence of CATSUD as a knowledge region and to take an active part in establishing the regional development strategy in conjunction with local authorities, social agents and civic representatives. To this end, the URV strives to be a globally engaged institution that educates open-minded, critical, and aware citizens, and which engages in research activity to help define global lines of action leading to a fair and sustainable world.

The URV's vision is to become a 'glocal' university where interactions between the university's global and local vision determine the impact of its activities. The URV aims to compete at the global level and, to do so, fosters the 'quadruple helix' at the regional level – university, administration, business and society – by means of projects promoted by the units mentioned above.

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