
1. Introduction

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It is well documented that some of the major technology regions owe their existence to their universities: Silicon Valley to Stanford University (Saxenian, 1983; Route 128 to the Massachusetts Institute of Technology (MIT) (Dorfman, 1983); the Research Triangle region to Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University (Goldstein, 2002); the Cambridge region to Cambridge University (SQW, 1985). These success stories attracted the attention of researchers and prompted the study of the role universities can play in nurturing regional development.

At the start of the 1990s, an extensive literature started to emerge, explaining the regional university effects along several dimensions: the multiplicative ‘expenditure impacts’ (Florax, 1992) of faculty, staff and student expenditures spent in the region; the ‘knowledge transfer impacts’ (Varga, 1998) including knowledge transmission via formal or informal local networks of university and industry professionals (university–industry research collaborations, local labour market of graduates, faculty consulting, university seminars, conferences, student internships, local professional associations, continuing education of employees); the diffusion of technology through formalized business relations (university spin-off companies or technology licensing); and knowledge transfers facilitated by the use of universities’ physical facilities (libraries, scientific laboratories, computer facilities). In addition to the impact of expenditure and knowledge transfer, universities may become important regional actors through their capital investments, their regional leadership and their role in influencing the regional milieu (Goldstein et al., 1995).

Recently written surveys provide structured overviews of the continuously and cumulatively growing empirical evidence emerging from the literature. Varga (2002) summarizes the early findings on university impacts, Drucker and Goldstein (2007) classify the various approaches in the literature, Arbo and Benneworth (2007), Lawton Smith (2007) and Goddard and Vallance (2011) provide critical reviews on the role of universities in regional development from different angles, whereas Varga and Horváth (2015) place the focus on the literature of localized knowledge transfers.

Research has made clear that the regional development contribution of universities is a complex and diverse phenomenon. The authentic mission of teaching is undoubtedly one of the most important ones, but over time it has been extended with research and social and economic development. The latter can range from activities such as external teaching, something that is highly accepted by the scientific community, to the establishment of spin-off companies, something that is more controversial. In order to understand the gradual extension of university missions, one cannot disregard the normative and institutional changes that went hand in hand with the academic revolutions, respectively the role of the different actors involved in the processes. It is also important that the whole issue is highly contextual and cannot be interpreted without understanding the differing framework and institutional conditions among which it takes place.

This Handbook studies the contribution of universities to regional development from three different but also interrelated aspects: the first part of the book characterizes universities as actors in regional development; the second part takes a closer look at the most important knowledge transfer mechanisms from universities to the regional economy; whereas in the third part we present case studies from three continents to provide micro views of actual university–region interactions.

Part I of the Handbook aims to discuss the historical evidences on how universities turned into multiple-product organizations and how they contribute to economic and social development on the regional level. Besides the historical evolution of land-grant and entrepreneurial universities, some less frequently discussed areas are also included, such as university engagement in cross-border regions, trusteeship at universities or high net worth individuals' contribution to the fulfilment of university missions.

Land-grant colleges and universities can be considered as one of the earliest institutional forms of higher educational organizations contributing to regional development. In Chapter 2, Nathan M. Sorber provides a comprehensive insight into the history of land-grant colleges. He argues that one can distinguish between four stages of land-grant colleges' evolution. The first started with the Morrill Act in 1862 and by enabling land-grant colleges to facilitate agricultural and industrial productivity, economic modernization, and nation-state building it represented a development paradigm that was rather more national than local. However, in the second stage, state-level implementation guided by populist interventions and progressive era reforms led to the rise of the local development paradigm accompanied by intense extension and outreach services. The third stage, following World War II, witnessed the rise of the human capital and knowledge advancement paradigms due to the transition from the industrial to the knowledge-based economy. The fourth, still ongoing, stage can be described by the privatization and commercialization trends that seem to be an amalgamation of the previous three paradigms in a new engagement framework accompanied by increasing commercial partnerships and the adjustment of the mission outcomes to the state and regional knowledge economies.

Henry Etzkowitz, in Chapter 3, introduces in detail the first and second academic revolutions that took place in the nineteenth and twentieth centuries and extended the core teaching mission of universities with research and regional development respectively. Though there were and are concerns related to the potential negative impacts of the academic revolutions on teaching and academic norms, respectively to privatization of knowledge instead of treating it as a public good, it can hardly be doubted that there was a gradual shift from the ivory tower paradigm of universities to what is mostly described as the entrepreneurial university, though the civic university and the engaged models also appear in scholarly works. The discussion of the impetuses of academic entrepreneurship, the concerns related to its spread and the role of polyvalent knowledge in the process all contribute to our better understanding of the current entrepreneurial processes in academia. Besides the introduction of prominent scientists' and universities' involvement in technology transfer, he also discusses the political and economic processes that contributed to the rise of entrepreneurial processes in academia.

In Chapter 4, Philip McCann and Raquel Ortega-Argilés overview those factors that can constrain universities' potential for regional development. They argue that, based on the concepts of triple and quadruple helices and respectively on smart specialization, universities are seen as key actors in regional development. However, they highlight that there are many factors that should be considered by framing policies and expectations. In terms of human capital

development of the region, the retention rate of graduates is of crucial importance. Universities as ‘honest brokers’ and ‘anchor institutions’ have the potential to act as knowledge network coordinators. Economic development has social and cultural aspects as well, both of them can be maintained and promoted by the universities as designers of civic spaces through their real estate development and repositories of this heritage. Also, specialized educational services for older cohorts contribute to local social development. Programmes for the development of knowledge and soft-skills of early and mid-career workers contribute to the employment transitions of the labour force. Universities can play a major role in the enhancement of entrepreneurship and innovation in the region through various activities ranging from education to joint research activities. Good practices of programmes and initiatives to enhance the regional development role of universities are also discussed.

In Chapter 5, Jos van den Broek, Franziska Eckardt and Paul Benneworth introduce the transformative development role of universities. They highlight that in many lagging regions there is almost no innovation and, based on Gunasekara’s (2006) concept, they also argue that in the frame of transformative development entirely new innovation activities are created. On the ground of six case study reports prepared for the OECD, they develop a conceptual typology of universities based on the active ways in which these institutions contribute to the establishment of cross-border regional innovation systems (CBRIS) in different stages of the development of CBRISs. The active ways are categorized as education domain activities, research domain activities, third mission activities (commercialization/valorization), governance activities, and institutional collaboration activities. In all of the regions, HEIs cooperate in the educational domain and this cooperation is stronger than the vulnerable bottom-up cooperation observed in the research domain. Also, internal activities do not necessarily result in increased integration of external activities. There seems to be a co-evolution of cross-border collaboration between HEIs and regional cross-border integration, however, the causality between these fields seems to remain unclear.

Previous chapters have demonstrated that universities provide multiple contributions to economic and social development and that, in many instances, have been accompanied by a rising tension between the costs and the revenues. In Chapter 6, Sheila Slaughter and Barrett J. Taylor argue that there was a timely coincidence of mutual reliance of university and industry, the former being in need of resources, while the latter being hungry for specific knowledge available at universities. The relationship of universities and firms is a complex phenomenon, especially in the decentralized higher education system of the United States where universities are governed by the board of trustees. A way to understand the power relations in higher education is to analyse the ways in which trustees, who are often executives both on campuses and businesses, connect the two actors. Observing changes in trustees and their company relations over time enables us to also gain insights into the connections of the institutions. Applying Fligstein and McAdam’s (2011, 2012) ‘theory of fields’, university–industry relations are analysed around the Great Recession based on the cases of two universities that are tightly connected to industry: the University of Pittsburgh and the Massachusetts Institute of Technology.

There are multiple ways in which universities contribute to regional development, however, the resources to fund them can be limited. In many instances, individual donors provide important contributions, but our knowledge on their role and impact is still limited. In Chapter 7, Emily I. Nwakpuda and Maryann P. Feldman provide an insight into the philanthropy of high net worth individuals who support university programmes with a focus on scientific research.

After introducing the theoretical fundamentals of philanthropy and its relation to higher education, they turn to the changing role of high net worth donors. Based on a nationally representative sample, they found that gift amounts have a right-skewed distribution and donors mostly donated to higher educational institutions located in their own state or region. The donors dominantly hold a management occupation. The analysis of funds donated to establish research centres revealed that the majority of the institutions receiving them were research universities and the average gift for this aim was more than four times the average gift size for all major gifts. Based on the evidence, there was limited economic impact found, however, there is an attempt by research centres established with gifts from high net worth individuals to have a broader regional development impact through successful inventions, entrepreneurship endeavours, teaching, medical treatment and community outreach.

Part II is dedicated to university knowledge transfer mechanisms. As such, it cannot ignore the discussion of patenting and spin-off activities, respectively the role of faculty in them. Furthermore, a complex network and geography of university–industry linkages is demonstrated.

In Chapter 8, Catalina Martínez and Valerio Sterzi express a critical view with respect to the current policy efforts to enhance university patenting. They argue that the linear model of technology transfer underlying most of the policy efforts and IP reforms does not really reflect reality – it underestimates the interactions between inventors and licensees and overestimates the role of TTOs as brokers in the technology transfer process. Furthermore, it actually leads to a severe underestimation of the extent of university invented patents. They argue that, instead of university patenting that covers the inventions owned by universities, it would be better to have a look at academic patenting that measures patents with academic inventors irrespective of ownership. This can be partly owed to the different IP systems in Europe that provide a scattered landscape ranging from Professor’s privilege to state ownership in terms of patent holders. In order to experience improvement in European knowledge and technology transfer they suggest ‘Alliances, combined with increasingly professionalized TTOs and complementary online match-making platforms’ where the institution (maybe jointly with the sponsor) would own the IP, but the inventor could decide how to manage it. Also, official metrics should be adjusted to incorporate university-invented patents to better reflect reality.

Spin-off firms contributed to the rise of some new industrial fields, for example, biotechnology, and they are also considered as a tool to facilitate regional development through universities since spin-offs usually tend to locate close to their parent organization. However, at the same time, it also has to be mentioned that other types of university outputs are more impactful and most of the spin-off companies do not grow into firms with significant regional impact. In this vein, in Chapter 9, Einar Rasmussen argues that in order to reveal the full potential of spin-offs, one should not ask ‘how substantial is the impact of university spin-offs?’ but rather the question should be raised ‘in what way do spin-offs contribute to regional stakeholders, such as their parent university, regional businesses and industry, as well as the society more generally?’. Based on a novel conceptual assessment of the existing literature on university spin-offs, Rasmussen provides a detailed insight into the regional impacts of these companies. After introducing the general impacts, he discusses specific effects related to the university level, the spin-off firm level, the level of other firms in the region, spillover to regional cluster and entrepreneurial activities, and regional societal impacts. Based on these, he proposes an agenda for future research and also provides policy recommendations.

In Chapter 10, Arne Vorderwülbecke and Rolf Sternberg focus on a specific role of alumni spin-off entrepreneurs by analysing the relative role that they play in universities' entrepreneurial support structure, respectively the way in which their contribution and the elements of the university's entrepreneurial support structure are impacted by alumni spin-off entrepreneurs. They conducted a qualitative case study of the Leibniz Universität Hannover (LUH) in Germany. Based on semi-structured face-to-face interviews, archival materials and official documents, they carried out a content analysis using qualitative data analysis software. They concluded that alumni spin-off entrepreneurs play an important role in the entrepreneurial support structure of the LUH, however, there are differences in their contribution considering the evolution and the reinforcement of this structure. In general, their impact on the overall evolution of the entrepreneurial support structure is very limited, however, they do play a crucial role in the reinforcement of existing elements of the entrepreneurial support structure through providing important information, know-how and practical experience. Based on the results they argue that actors in charge of a university's entrepreneurial support structure should seriously consider the involvement of alumni spin-off entrepreneurs in their efforts.

Based on the existing literature, Katalin Erdős provides an insight into the diverse world of academic entrepreneurs in Chapter 11. Besides revealing the institutional context and the norms of different waves of entrepreneurial activities of scientists, she also provides a categorization of academic entrepreneurs. She highlights that the early forms of commercialization in engaged universities treated knowledge as a public good. However, recent forms of academic entrepreneurship can be considered as commodification and treat knowledge as a private good. It is also revealed that there is not a single type of academic entrepreneur, but there are many who differ, for example, in terms of motivation and levels of involvement. The differences can influence the exploitation of potential synergies between academia and business, respectively the level of tensions between them. At the same time, there are many scientists who still refuse any form of commercial engagement. The primary reasons behind this are concerns related to the norms of science, respectively the potential conflict of interest and conflict of commitment. On the other hand, it seems that only a few researchers still participate actively in the past few decades of highly promoted forms of academic entrepreneurship, for example, spin-off establishment. The majority of scientists seem to prefer some level of involvement, primarily in engagement activities that should be considered when designing policy measures to promote knowledge and technology transfer.

If it is about knowledge and technology transfer, one cannot evade diving into university–industry interactions. In Chapter 12, Andrew Johnston and Robert Huggins critically analyse the interrelationship between the concept of geographic proximity and the more relational concepts of networks and innovation systems from the perspective of linkages between universities and firms in the knowledge-intensive business service sectors (KIBS) in urban and rural areas of the United Kingdom. Geographic proximity seems to be a more important determinant for the development of collaborative linkages in case of urban KIBS that are usually located in more competitive environments and have access to more universities in their vicinity than their rural counterparts. They are also more likely to cooperate with universities with stronger track records in knowledge commercialization than rural KIBS. Regional innovation spaces are not fixed places of knowledge stocks and assets, but rather 'spaces of knowledge flow' (Huggins, 2011). Consequently, it is reinforced by the findings that there is no one size fits all model for knowledge-based development. They also highlight that effective regional

innovation systems should provide access to knowledge for both local and external firms if needed and policies should support match-making of firms and universities.

Part III involves a bouquet of case studies from three continents: Europe, Asia and South-America. Since many chapters in this book reflect the North-American context here we intend to shed light on countries that are rather different from the United States or Canada. The European studies start with an account of the contributions of universities to regional development in a leading biotech centre in the United Kingdom followed by a chapter on public engagement of two universities in two regions of Austria and an analysis of university–region relations in lagging areas of Hungary and Slovakia. A chapter on three post-Soviet countries (one from Europe and two from Central Asia) acts like a bridge between the two continents. The two chapters on China and Vietnam provide insights into the university role in Asia whereas South America is represented by a Brazilian case study.

The importance of the commercialization of scientific inventions in bioscience and life sciences is well demonstrated by the literature. In Chapter 13, Helen Lawton Smith, Sharmistha Bagchi-Sen and Laurel Edmunds focus their analysis on the role of Oxford University and Oxford Brookes University in the Oxfordshire bioscience sector. Based on an extensive data collection from different sources they analysed the Oxford and Thames Valley and compared it with other three European biotech centres; Medical Delta (Netherlands), Life Science Zurich (Switzerland), and Biocat (Spain). They found that the two universities are important actors in the country's bioscience cluster, however, there are differences in their direct and indirect impacts. Besides being seed beds of spin-off companies, they also represent an important contribution to the physical infrastructure. At the same time, there are structural problems that stem from the under-investment in the United Kingdom's biotech firms that mitigate the impact of investment research and translational research compared to other European locations. Also, the supply of highly qualified labour seems to be weaker than in the competitor regions analysed. Furthermore, though Oxford University is a global centre of research excellence and an important player on the local, regional and national levels, its major partners are located outside of the region that might results in spillover effects.

Harvey Goldstein, Verena Radinger-Peer, and Sabine Sedlacek focus on the public engagement of universities in Chapter 14. This chapter covers 'the use of know-how and expertise within universities for regional problem-solving, leadership, and the enhancement of regional development through the strengthening of the regional economy and civil society'. Technology transfer is not excluded from the analysis, but it is very important that it must target the region where the university is located in order 'to build and sustain a healthy social economy'. In order to have empirical evidence, they made a comparative case study of two medium-sized Austrian universities, the Karl Franzens University (KFU) in Graz, Styria, and the Johannes Kepler University (JKU) in Linz, Upper Austria. They argue that it might be very difficult to convince faculties to take part in these types of engagement activities in the era of constrained resources and increased focus on commercialization activities that bring higher visibility and revenue. It is very important that university leaders act as role models in this sense and foster good relations with industry and regional government. The foundations they can build on during their effort for enhancing engagement is the moral responsibility to 'give back' to society and the self-interest of becoming a more successful institution being located in a region that is strengthened economically and socially as a result of university engagement.

In Chapter 15, Zoltán Gál and Pavel Ptáček discuss the role of non-metropolitan mid-range universities in five Central European regions, where the path-dependent evolution of the knowledge and technology transfer systems limits their potential contribution. Both the Czech Republic and Hungary are demonstrators of post-communist systems that had an impact on the organization of science and the relations of the academic and business spheres. On the back of the regional engagement literature, they conclude that the regional innovation system should be nurtured in its entirety in an integrated manner in order to develop the regionally engaged university. They argue that in order to achieve progress and increase knowledge transfer and spillover in the local economy, R&D capacity development in science and engineering might be needed that is tailored to the region's needs. Furthermore, a critical mass of linkages between local businesses and universities should be achieved before one would expect immediate increase in growth and jobs based on smart specialization and innovation-oriented regional development plans.

In Chapter 16, Annamária Inzelt provides an insight into the state-of-the-art academic knowledge-based entrepreneurship in three minor post-Soviet economies: Armenia, Belarus and Tajikistan. These countries have many commons related to the Soviet legacy of science organization and intellectual property right models, however, the speed of their transformation is different. Based on document analysis and interviews, she concludes that the change has started, the regulative framework conditions were modified and government programmes were initiated to establish science and technology parks and to enable spin-off formation, for which there are some successful examples. A key question is whether these successful spin-offs will be able to become growing companies based on their current competences. Inzelt also highlights that there is still a lot to do, both in terms of regulations and attitudes to support academic knowledge-based entrepreneurship. The strong legacy of the Soviet system and the dominance of the linear model of innovation still represent an obstacle and there are deficiencies on the level of academic organizations as well. This is partly due to inexperienced TTOs and unclear regulations that all contribute to the limited commercialization of knowledge.

Yuzhuo Cai, Po Yang and Anu Lyytinen reveal the importance of universities of applied sciences (UASs) in regional innovation in China by integrating the Triple Helix model and the entrepreneurial university concept in Chapter 17. They argue that owing to their efforts in the past two decades, UASs can strategically position themselves to serve regional innovation systems by providing qualified knowledge to workers and serving local industry with testing, development and applied research. However, they have to overcome institutional barriers, for example, lack of legitimacy, technical capacity and resources in order to become reliable partners for regional development. They also argue that UASs first have to develop their research capacity in line with the entrepreneurship university model in order to be able to act in the sense of the Triple Helix by taking the role of the government and business. Not only UASs, but also higher policy levels have to take measures to support the transformation. National legislation should encourage UASs to pursue applied research and talent cultivation, whereas local and regional governments should establish the strategic and policy framework, respectively financial, human and infrastructural resources for UAS's involvement in regional innovation systems.

A further Asian case study sheds light on the transformative role that multinational enterprises (MNEs) exert on the Vietnamese higher education through their corporate social responsibility (CSR) in the form of provision of scholarships, equipment donations and training

programmes. In Chapter 18, Jöran Wrana, Moritz Breul and Javier Revilla Diez argue that as a result of the heritage of the socialist system, universities' only contribution to regional development was through the provision of human capital. However, a mismatch evolved between those skills and knowledge that the higher education system was able to provide to students and the ones that were required by the market and the latest technologies. Though the beneficial impact on regional development is evident, the rise of proto-institutions was partial, that makes positive spillover effects in the broader university system unlikely. The reasons for this are partially systemic obstacles, like big class sizes or missing incentive systems for implementing new teaching methods, and the low level of university leaders' motivation. A further issue is related to the types of skills developed through these programmes. Many MNEs put an emphasis on product promotion or binding students to their companies through firm-specific technical skills and technologies, whereas the development of soft and foreign language skills for example are rather exceptional.

It has already been demonstrated that companies originated from universities can contribute to knowledge and technology transfer. In Chapter 19, Thiago Renault, Sérgio R. Yates, Leonardo Melo and José Manoel Carvalho de Mello reveal how innovation habitats created by universities can foster this process. After providing a general description of the Brazilian STI environment and the role of universities within it, they compare two cases of leading Brazilian universities that intend to shape their innovation habitats in terms of infrastructure, services and trajectory. The Federal University of Rio de Janeiro (UFRJ) is the oldest university in Brazil and the largest federal one ranking eighth among the top 50 Latin-American universities (Times Higher Education). The Pontifical Catholic University of Rio de Janeiro (PUC) is Brazil's leading private research university ranking ninth among the top 50 Latin-American universities. In both cases the process of incorporating organizational mechanisms to foster university-business interaction started with an incubation programme followed by an intellectual property office and by the attempt to create a Science Park. However, the implementation of the first two mechanisms created tensions between them owing to their separate treatment. An important difference is that while PUC efforts were triggered top-down, the UFRJ demonstrates a bottom-up process.

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