
Entrepreneurial Universities – Towards a Revised Paradigm[†]

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Abstract

This article provides a comprehensive review of the entrepreneurial university concept and its place and role in the triple helix of university, industry, and government. This is increasingly important because stakeholders' expectations towards universities are growing; this growth in turn leads to increased pressure on universities to move beyond their traditional roles and models towards taking responsibility for economic development, large scale basic education and targeted further education and the development of value from research. These expectations provide opportunities for universities, but impose threats on the existing models and practices. It further elaborates on implications for university management, departments, faculty members and supporting organizations. Moreover it reflects on the meaning of the entrepreneurial university for stakeholders, i.e., university boards, regional and national policy and administrative bodies, funding agencies, the business community, university ranking institutions and the global university community overall. Recent literature on entrepreneurial universities is incomplete and mostly focused on the commercialization of research, technology transfer and the third mission of universities. The article expands the predominant thinking about entrepreneurial universities and gives a broader structured definition. Eventually the article shows the need for STI policy to intervene and measures for developing entrepreneurial universities further.

Keywords

triple helix, knowledge triangle, entrepreneurial university, university-industry linkages, open innovation

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1. INTRODUCTION

STI Policies and Entrepreneurial Universities

Science, technology and innovation (STI) are recognized as significant drivers of economic and social welfare of municipalities, regions and ultimately countries. Having this in mind, STI policy makers have sought for approaches to stimulate scientists and engineers to develop unique solutions and approaches, which are commonly termed innovation. The role and contribution of universities to achieving this ambitious goal of innovation has achieved strong attention. To some extent, this is rooted in the “smart specialization” concept which nearly became hype until recently. Yet, although the underlying intention is doubtless positive and constructive, numerous challenges remain for universities to achieve considerable and measurable impact on innovation (Schibany & Reiner, 2014). Public research done at universities has historically been the source of important technological and innovation breakthroughs. Today university research continues to perform a wide range of functions in various disciplines, including conducting fundamental and “strategic” pre-competitive research, offering technological support to business and public policy, helping to create and implement technical norms and standards, and constructing, operating and maintaining key facilities.

Consequently, especially in recent years, an escalating demand for STI infrastructure has been observed on a global scale (Demirbag & Glaister, 2010; Gokhberg & Meissner, 2014; Meissner, 2014; Mrinalini & Wakedkar, 2008). The internationalization of research and development (R&D) offers opportunities for countries to design an STI infrastructure which invites companies to take advantage of the national STI infrastructure and related skills, eventually leading to the generation of positive spillovers that support the development of national economies (Bsakaran & Muchie, 2008). In addition, STI should help cope with social challenges, such as health and environmental problems (Guinet & Meissner, 2012).

Universities are a major actor in national STI infrastructures with multiple missions and tasks to fulfil. The idea that research and science have a positive effect on - and are an essential prerequisite for - innovation in the economy increases with the current modernization and globalization, particularly in the course of technology diffusion, which has established itself as an important production factor. For this purpose, basic and applied research provide an important and complementary contribution to the development of new areas and enhance of competitiveness by making findings from basic research available for the application of interest (Schibany & Reiner, 2014). This happens at a time when innovation processes themselves are undergoing major changes, raising new challenges for innovation-aware corporate managers and public policy makers. The notion of “open innovation” has been carved to capture the combined effects of the most important of these changes, to wit: More distributed, multidisciplinary, trans-border, cross-institutional and inter-temporal innovation processes.

As the amount of existing knowledge and related competencies to apply that knowledge increases

and combines into new multidisciplinary clusters, the opportunities for innovative answers to the diverse demands from society grow even more rapidly. At the same time, fewer innovators have the necessary resources to exploit the opportunities that arise in increasingly globalized markets; an increasing proportion of innovations result from the sharing of competencies between different players along and beyond the value chain, with deep implications for industry-science relationships and related policies (Cervantes & Meissner, 2014). In particular, new forms of complementarity between business and public (university) research arise as a result of the need to reconcile speed in the commercial exploitation of new ideas on highly competitive global markets with continuous investment in the long lead-time of the development of radical innovation capabilities. Universities play a crucial role in this context given their dual role in education and research; i.e., the foundation for innovators is often laid in the university curriculum and front end research projects, which are among the drivers for creativity of graduates who in turn develop into innovators over time (Bell, 2010; Sivak & Yudkevich, 2008). Yet, there is a reasonable time lag between the educational efforts and the resulting impact on innovation which makes it difficult to trace causality between education and innovators' competencies and capabilities.

Governments have to adapt to changes in business innovation activities in order to derive the expected social return on their own investment in knowledge, notably in the public STI sector via universities, and to make sure that the incentives they provide to firms and their business environment help to effectively leverage global innovation networks for the development of national/regional innovation capabilities. Therefore, consistent and coherent STI policy approaches are required which reflect the changing reality in the STI landscape not only regionally and nationally, but also globally. Universities are important actors in the respective STI landscape of all countries, which is why the paper identifies the aspects of entrepreneurial universities in light of the changing nature of innovation processes and the resulting challenges for STI policy makers.

The article proceeds as follows. First, the “entrepreneurial universities” concept is analysed in light of the Triple Helix and the Knowledge Triangle. The next section discusses the entrepreneurial university and external linkages, then introduces a modified entrepreneurial university paradigm. The concluding section develops a framework for the main stakeholders, organizations and units involved in the entrepreneurial university and conclusions for STI policy.

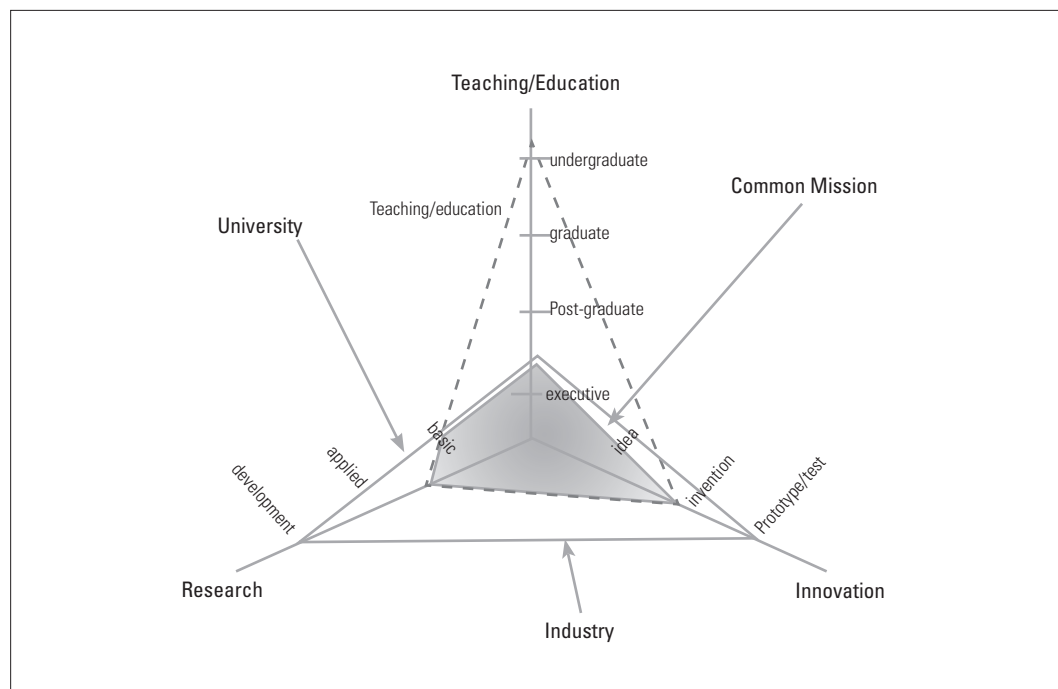
2. ENTREPRENEURIAL UNIVERSITIES IN THE TRIPLE HELIX AND KNOWLEDGE TRIANGLE

The role and meaning of universities as principle actors in the STI landscape for the wellbeing of societies is frequently discussed by many different interest groups. In principle, universities are thought to be places of free thinking beyond the level of society's current knowledge, seeking to explain complex phenomena which are not yet widely understood. In this regard, universities are expected to function as think tanks, providing knowledge to decision makers at different levels. This gives an advantage in the sense that “knowledge is power,” hence knowledge endows people

and countries with power and control. This common wisdom is one of the major motivations for governments to establish and support public universities and to allow private universities to exist. It is important to note that the difference between public and private universities does not appear in the funding structure alone. Rather, the difference is shown in the organizational framework and the decision power of the steering bodies of the institutions, culminating in the resulting freedom of research and teaching staff.

The term, “entrepreneurial university” has been in frequent use since the early 2000s when Etzkowitz and Leydesdorf (2000) stated that universities are confronted with the quest to fulfil a third mission in addition to education (teaching) and research, which they postulated to be innovation. This “Triple Helix” model of knowledge production stresses three “helices” that intertwine and, by this, generate an innovation system: academia/universities, industry, and state government (Etzkowitz & Leydesdorff, 2000). The Triple Helix may be regarded as a fundamental model for innovation, resulting from interactions in knowledge production referring to universities (higher education), industries (economy), and governments. From this argument, they concluded that the university model is shifting towards an “entrepreneurial” model that stresses the application and exploitation of research, i.e., technology transfer. In this regard, the term “entrepreneurial university” is misleading because it emphasizes the entrepreneurial activities of universities above research and teaching. Rather, the underlying assumption is that universities are developing strategies in all three fields and implementing them accordingly (Figure 1).

FIGURE 1. The Overlap of Universities’ and Companies’ Focus in the Triple Helix Model



At first sight, one might argue that there is a reasonable overlap in the basic missions and activities of universities and companies, which, in principle, is true. However, the generalized picture is not applicable to real conditions for several reasons. The intensity of the activities of universities and industries varies in all three dimensions. Therefore, the assumption that universities and industries' activities are complementary is not justified in all instances. Also, each of the missions imposes completely different requirements and expectations on the actors, with respect to universities and companies. Aligning these is an ambitious undertaking which requires wide-ranging support in the respective organizations. Finally, the actors are subject to different legal requirements imposed by governmental initiatives and the legal framework. Whereas for companies the liberal market context allows unlimited access, universities frequently enjoy the protection of academic freedom by law (often fixed in national constitutions). This puts universities in the unique position of making decisions about the use and application of knowledge and technology. This holds true for the university as a whole, but varies between faculties and schools even at the same institution (Martinell, Meyer, & von Tunzelman, 2008).

The challenges for universities that arise from changing the research, education and innovation environments are found in a more interactive and feedback-driven transfer approach of research competence and results. This replaces the traditional linear knowledge transfer approach and drives a quest for universities to reorganize research agendas and portfolios to address new technology developments, stressing interdisciplinary collaboration (Youtie & Shpairo, 2008). Despite the fact that many universities have established dedicated units to support technology and knowledge transfer, a reasonable share of relationships between university members (including research and/or teaching staff) are engaging in bilateral external relations aimed directly at innovation without involving these dedicated units (Siegel, Waldman, Atwater, & Link, 2004).

It is the common view of governments that university attracts foreign direct investment targeted to R&D activities. This belief can be traced back to the work by Luger and Goldstein (1997) who postulated that the human resources trained and educated by universities and the transfer of research results and research competencies, which are core to universities, generate respective spillovers which companies are taking into account when establishing R&D facilities. Therefore, governments aim at developing regional innovation ecosystems which include private R&D investment-friendly frameworks which are in turn assumed to attract follow up investment into other stages of the value chain. The impact of universities takes many different shapes, but mainly it is believed that universities fulfil the role of a "knowledge hub" with a primary regional outreach for the developed competencies (Youtie & Shapira, 2008).

Furthermore, it needs to be reiterated that universities are frequently publicly funded with close links to public bodies such as governments. In this regard, university staff at all levels are de facto government staff, under the steering and control of public bodies and more or less directly forced to fulfil tasks and implement strategic ambitions imposed by governments. The latter is an issue which is rarely debated, being implicitly known and accepted. Dooley and Kirk (2007) argue that technology transfer is often a one-way channel for moving existing technologies and knowledge (which

stem from universities' activities) into a company's innovation processes, but rarely integrates feedback loops which potentially inspire universities to design their own research activities. Moreover, the discussion and analysis of industry–science linkages focused for a long time on the core of the transfer, namely knowledge and technologies from universities, while little attention has been paid to complementary sources of specialist knowledge such as consultancies and private research institutes. Such knowledge-intensive business services (KIBS) are becoming increasingly important in creating and commercializing new products, services and technological processes. Such institutions should not be neglected as they are a valuable part of innovation systems, complementing the capacities of universities and other public research organizations.

Universities also need to be seen in a regional and national context, because different countries and regions are at different stages of development (Bramwell & Wolfe, 2008). Highly developed economies which put a strong emphasis on upgrading the national economy to a knowledge economy, digital economy or related concept, assume that industry possesses the necessary absorptive capacities to successfully “digest” and apply universities' research and teaching output (Etzkowitz, Ranga, Benner, Guarany, Maculan, & Kneller, 2008). Depending on the national context, universities might have to develop human resources to upgrade a country to a knowledge economy. Therefore, universities within this context would mainly be challenged by their educational function instead of delivering technology to industry for further application. Furthermore, universities' research activities in these countries are focused on the absorption and assimilation of incoming technologies from the global scientific community with little being done on completely new knowledge generation (Wong, Ho, & Singh, 2007). The reason is found in the national economy's structure, which is often natural resource or commodity based; thus, a basic technology base has not been developed. There are a reasonably large number of countries which are on this development trajectory. Most of them discover that over the course of this transition, the low-wage feature of the economies is increasingly replaced by the call for higher wages, which is typical for knowledge-based economies; however, the transition period is significantly longer than commonly expected and understood. In this light, there is the view that well-established, highly reputed institutions are best equipped to provide the necessary education and training required.

3. THE ENTREPRENEURIAL UNIVERSITY AND EXTERNAL LINKAGES

Until recently, “entrepreneurial university” was understood as a university which engages in the commercialization of its services in education and research, hence delivering its own innovations or significantly contributing to innovations by spin-offs from the universities. The term also needs to include the education and the actual research mission of universities. Whereas Etzkowitz et al. (2000) postulate the exploitation function of research results as the core of the “entrepreneurial university,” this thinking needs to be extended beyond the original horizon for the following reasons:

1. The pure focus on technology and knowledge transfer does not reflect the breadth and depth of content developed by universities in terms of research performed and educational

programs designed.

2. The linkage of a university's internal knowledge transfer between research and education is not considered at all.
3. The full potential of the range of available knowledge and technology transfer channels is not covered by the sole focus on technology transfer and commercialization.
4. This focus ignores the technology life cycle and the often immature technologies under consideration for transfer.
5. Considering a university an "entrepreneurial university" based on the technology commercialization aspect alone would require a significant reduction of universities' portfolio of activities and make university management accounting and control the uppermost concern, as well as narrowing the faculty's short-term mindsets to meet stakeholder interest and the resulting requirements.

The now predominant understanding of the "entrepreneurial university" is too narrow because it does not reflect the full range of linkages between universities and the other actors in the national innovation system, the Knowledge Triangle. These linkages typically cover the full spectrum of universities' activities and its relationships with the surrounding actors and are described in the following paragraphs.

Well-established linkages between universities and industry as well as governments are found in the **education and further education** role of universities. Here the actual tertiary education at the undergraduate, graduate and also postgraduate levels, together with targeted further education programs, is one long-established channel of transferring knowledge and technology. The challenge for entrepreneurial universities is to adapt the curricula to changing requirements while maintaining high quality levels.

It has frequently been observed that universities introduce full-fledged programs entitled *entrepreneurship*, *innovation management* or something similar to meet the challenge of entrepreneurial education. This is imposed on universities primarily by governments, and partially by companies. The underlying assumption is that such programs inspire currently enrolled students to take entrepreneurial and innovator roles and also motivate university research staff to do the same. Although this may motivate students and employees to consider different paths for their future careers, it hardly reaches the full audience to raise awareness about innovation and entrepreneurship on a wide scale. There is some episodal experience that shows integrating innovation and entrepreneurship in existing curricula on a very modest scale, for example by complementing core course of engineering, natural and social science programs, shows a strong impact because students in such fields are becoming familiar with the entrepreneurship and innovation at the early stages of their education and professional careers.

Further education programs, including executive education, complement the educational programs offered by universities. These programs are typically designed to meet the demand of a targeted group of companies or individuals for special topics and learning needs.

Debates about the entrepreneurial university and the Triple Helix frequently consider **R&D cooperation** between universities and, primarily, companies as the main features used for describing the entrepreneurial spirit of universities. However, such cooperation varies in extent, scope and duration among many other typical project features. The most widespread linkage appears in form of contract research, which is aimed at universities working on a predefined subject under a formal contract with a commercial company. A similar structure is found in *joint research projects*, where a university and a company undertake to cooperate; this may involve several universities and companies. In this case, it frequently happens that research or innovation funding agencies are involved through financially supporting these activities. More recently, *public private partnerships for STI* (STI PPP) are emerging which bring together universities and companies for research and innovation. These are commonly designed for longer terms and work on bigger and more complex topics and projects than contract or joint research undertakings. In addition, universities and their employees are typically involved in networks such as cluster organizations or technology platforms, among others, which aim at research and innovation partnerships.

Another important channel for transferring technology and knowledge between industry and universities as well as governments and governmental bodies is by means of **scientific communication** including scientific publications, conference presentations and academic communication between scholars. These channels of communication may involve traditional hard copy *journals* or *books* as well as through personal interaction at academic events. *University libraries* are also a frequently used source of information and knowledge for non-university employees when it comes to gathering complementary knowledge or information which is not strictly connected to actual research- or innovation-related challenges.

Another related channel is *doctoral students* and their respective *doctoral studies* which attempt to expand the horizon of scientific knowledge. These works increasingly include the application of the underlying scientific work, which makes them valuable for use by industrial communities. Furthermore there is a tendency for universities to accept and supervise “external doctoral students,” who hold positions at companies or other organizations outside universities while performing doctoral studies. This approach allows for a targeted analysis of phenomena which are relevant for application and use but not fully covered in the scientific community. The same appears in case of the *graduate thesis*, i.e., the Master’s thesis, which often focuses on the application of existing knowledge and solutions for specified tasks and challenges and are done in cooperation with universities and companies or governments and their affiliated bodies.

In addition to the channels in this section, there are *sponsored professorships or institutes*, which, though financed by a non-university sponsor are per se independent from any external influence, but are often complemented with boards or councils who possess significant influence over the research agenda of the professorship or department. Accordingly sponsors of such entities are frequently members of directing councils or boards and therefore possess reasonable indirect influence over the entities’ activities.

As well as the linkages described under education and scientific communication, **information and communication technology**-related channels need to be touched upon. *Scientific and technical information* (including patents) as well as publications are commonly stored on online databases operated by different actors. These depositories have only recently begun to change from paid models to open access models. These emerging open access databases are broadly recognized as enabling faster diffusion of information to a broader audience. Another frequently used informative channel are *social media platforms* and *topic specific communities and networks* including blogs among many other forms, which share information and expertise and facilitate the exchange of experiences, views and assessments within and beyond their communities.

Over the last several decades, universities began to increasingly use **intellectual property rights (IPR)**. Universities focus most on patents and the commercialization of patents by using different exploitation paths such as licences, sale of patents, or using patents as investments into spin-off companies and the like. Less frequently, universities may engage in trademarks and related IPR. The challenge for universities' engagement in IPR-related activities is first and foremost to develop and establish a seamless invention disclosure scheme, which takes into account the special organizational structure of universities and the corresponding obligations between the university and its employees. Furthermore, university research activities are often thought to be very basic in nature, therefore with dubious profit in application and limited potential for exploitation, making them considered ineligible for IPR. This conclusion is debatable and is, at best, applicable to a limited number of science and research fields only. The bigger problem seems to be the establishment of professional IPR management capacity at universities which does not conflict with the research and publication missions of the institutions.

Other frequently used and important linkages between universities and external organizations are found in the broader **mobility of individuals** and **spin-offs** from universities. Mobility of individuals refers to the mobility of university employees to take fixed term positions related to their original field of expertise at companies, governments or other organizations, while preserving the right to return to their original position. Such models have seldom been found in practical application until recently, whereas supporting spin-offs has been supported by universities for a long time. Both approaches provide a clear indication of the entrepreneurial attitude and shape of a university because it demonstrates and visualizes the underlying motivation of a university to achieve a visible impact from its original missions.

The broad range of linkages or channels used by universities are typically bundled and managed within a dedicated service unit, named the "**Technology Transfer Office**," "**Industry Liaison Office**," "**University Incubator/Accelerator**," or something similar. Not only do the services offered by these entities vary, but also do the organizational structure and the alignment of them in the university organization itself. Among the biggest challenges for these entities is gaining acceptance within both the scientific community and the industrial community. It can be said that the mere analysis of university–industry linkages in the Triple Helix and Knowledge Triangle context is misleading. It causes a partial misunderstanding of the entrepreneurial university because it implies a

strong application orientation of universities leading to widespread short-term thinking, which is mainly due to the lack of evidence of the contribution of university activities towards innovation ecosystems at different levels in the long term.

It is agreed that the educational activities of universities form one extremely important link with companies and governments, especially as it is broadly understood and accepted that the quality of education is one major cornerstone of graduates' future professional performance. R&D cooperation has been a long established channel for transferring knowledge and technology in different directions, although this connection is mainly from universities to companies, providing immediate value to only the companies. However, such cooperation is also a source for inspiration for universities when it comes to identifying future fields of research. For example, from experiences in R&D cooperation, universities can also become more informed and draw conclusions about the need for research in selected fields. In addition, IPR is a feature of entrepreneurial universities if treated carefully and expectations concerning potential economic impacts are kept low. It should be thought of distinctly as IPR management for universities, which is different from company IPR management in many ways. Moreover, scientific communication is not fully reflected in the understanding of the entrepreneurial university and also only occasionally in the discussion about industry-science linkages, the knowledge triangle or triple helix.

4. A REVISED “ENTREPRENEURIAL UNIVERSITY” PARADIGM

A revised “entrepreneurial university” paradigm needs to take into account the diverse challenges universities are facing. Universities are frequently focused on extending their outreach not only by means of publications but also by means of the internationalization of faculty as well as students. By opening up to international faculty members and students, universities achieve a broader global reputation but probably more importantly, they enhance competition for potential faculty members and prospective students who are interested in affiliating with the university. In other words, it is clear that the internationalization of faculty and students extends the impact and reputation of universities from a local dimension towards a broader recognition. However, there is not sufficient space for universities in the world to develop and maintain global recognition among researchers and teachers as well as students. Publicly funded universities are increasingly confronted with pressures by stakeholders to use public funds for local or national employees and students, fostering development of local and national innovation ecosystems and creating local and national competitive advantages rather than educating and training potential competitors abroad (O’Shea, Allen, Morse, Colm O’Gorman, & Roche, 2007).

Dooley and Kirk (2007) argue that in the long term, one pre-condition for universities to attract third party funding (namely government research and innovation support) is excellence in research and specifically, excellence in formulating research proposals and communicating research projects.

In the case of faculty members, research competition is intended to attract the brightest minds. From a student standpoint, international student cohorts not only contribute to an intercultural milieu but also have the possibility of creating local and internationalized alumni networks. Communication between alumni is frequently used for different aspects of academia but also commercial (business-related) issues (Wong, Ho, & Singh, 2007).

Incorporating the entrepreneurial mindset into students' attitudes is not meant to prepare students to found companies during or after their studies, but it is a means of preparing students for the changing conditions in the labor market, which in many industries and countries is characterized by an increasing share of fixed term appointments. The entrepreneurial mindset is thought to provide students with the ability to take this changing labor market into account early in their educational and professional careers.

Although often viewed with prejudice, external linkages do not limit the actual research work by university employees. On the contrary, practice shows that these linkages provide valuable information and inspiration sources for university members (Siegel et al., 2004). This is supported by the findings of Azoulay, Ding, and Stuart (2009), which provide evidence that protecting the outcome of research by means of intellectual property rights (patents) does not impact the research activities of a scientist. Instead, the literature supports that researchers who actively use intellectual property rights tend to be more open to collaborating with industry researchers, which is reflected in more co-authored publications between scientists and industrial researchers. Also, there is no evidence that the scientific activities of researchers who patent suffer. Siegel et al. (2004) found that reward schemes for university employees are designed in such a way that they emphasize the research mission of universities almost exclusively. Indeed, the innovation mission expressed in the transfer activities is not fully reflected in the evaluation schemes. Instead it is a common practice to consider third party (external) funding raised by university employees as an appropriate means to measure their contribution to the innovation mission. However, the challenge remains to distinguish between the different types of external funding.

The term "entrepreneurial university" needs to be further explained and analyzed by extending the understanding of "entrepreneurial" from application-driven inspirations towards the fullest meaning of the term, which implies ongoing changes and overcoming routines including potential negative impacts and threats resulting from standard routines during ongoing activities. With these in mind, one might define "entrepreneurial universities" as

Universities who are undergoing continuous change in their activities, adjusting them to current and potentially expected demands from stakeholders and aligning their activities to explicitly deliver value to society. Entrepreneurial universities develop an internal culture of academic freedom, scientific values and awareness of emphasizing 'value thinking' in education and research. They establish, maintain and expand linkages with other research and education institutes, companies and governments. Entrepreneurial universities' activities are characterized by entering new grounds in their respective fields which are not yet fully ex-

plored by other institutions.

The so developed understanding of the term and concept “entrepreneurial university” allows one to describe the challenges for all university staff at the different levels:

- *Departments including university professors and other faculty members* who form the core of the ‘entrepreneurial university’ are increasingly forced to adjust their curricula and research portfolios in order to generate aligned outcomes such as graduates and research results. This is an area which inherently threatens the academic freedom of departments and calls for a change to the process of research portfolio and curricula development. Such measures need to balance the freedom of intellect against the quest for applicable outcomes in order to assure the sustainable performance of the institution. Herewith it needs to be noted that the performance of universities in many cases is facilitated by their reputation because universities with a strong global reputation are highly attractive as places to work for talent. To develop and maintain excellent performance and reputation, an understanding of the complex entrepreneurial university, Knowledge Triangle and Triple Helix thinking is required. This can help faculties and professors to formulate responses to external inquiries and to prepare strategic initiatives to foster excellence while maintaining academic freedom in their fields.
- *University Management* at all levels is frequently challenged by stakeholders, namely by university financiers, to adapt to the Triple Helix and Knowledge Triangle and shift toward the entrepreneurial university model. However, they find it hard to fully understand what the stakeholders might mean and what the inquiries imply. Hence for senior university management, it is important to have a common and contextual understanding of these concepts enabling them to respond to challenges accordingly, in the interest of the university. This is equally important for middle management because it is they who convert the strategic decisions of senior management into action and therefore with a deeper understanding they can provide a much smoother and more targeted implementation.
- *University boards and councils* are typically found at all levels and units of universities overseeing the activities and approving strategies and funds, among other functions. In this respect, they form powerful bodies within the institution contributing to the long-term orientation of the respective entity. Therefore, board and council members need to understand the full potential impact of their decisions and how these may shape their universities, leading to an entrepreneurial university.
- *Knowledge and Technology Transfer Offices / Industrial Liaison Offices (KTT offices)* need to take a systemic view on the entrepreneurial university in order to better align their activities with the actual and arising needs and requirements they face by their respective counterparts. Typically counterparts of these offices are companies and governments on the one hand, and university employees on the other. The challenge for KTT offices is to contribute

to the establishment and maintenance of respective linkages while understanding the difference between the ecosystems in which university employees and companies/governments act. Furthermore, KTT offices are often associated with an image which is less positive and casts them as administrators and bureaucrats.

- Meanwhile, it is common practice that *policy makers and governments* formulate requirements for universities, negotiate targets to be achieved by the universities and couple funding to these targets. Although these targets often reflect individual features of the Knowledge Triangle and Triple Helix, they rarely mirror the full picture and therefore they direct the universities in an unbalanced manner according to popular topics of the moment. Policy makers need to partner with the entrepreneurial university's understanding which reflects both the overall institution and its environment, to understand the full impact of their proposed rules and key performance indicators.
- *Funding Agencies* have become important actors for funding research not only at public institutions such as universities and public research institutes, but also for corporate research and innovation activities. These agencies typically finance research under the constraint that this work satisfies requirements stemming from a partial understanding of the entrepreneurial university concept. It is essential that funding agencies learn and understand the overall function and the increasing role of the entrepreneurial universities when designing funding programs and allocating support. This is mainly relevant for these agencies when it comes to setting funding priorities, assessing funding applications and designing reporting and evaluation procedures. As they steer the public funds, such agencies indirectly influence the choice of the topics of applications.

Interactions between entrepreneurial universities and companies follow the clear aim to enhance companies' innovation competence base and capacities; hence, these interactions are considered beneficial for all parties (Dooley & Kirk, 2007). For universities and companies especially, the following advantages appear:

1. *Companies* frequently appreciate the opportunity to complement their own abilities with the university competence base, which is typically a science and technology niche from the company's point of view but is still connected with excellence in this field. Such university-company links are perceived as advantageous by companies who aim to stay at the frontier of science and technology, as they would have access to tacit knowledge possessed by the scientists and thus an advantage over competitors whose access to respective knowledge is limited to documented knowledge. Furthermore, in selected cases companies can access and use sophisticated university equipment which might not be available within their organizations.
2. *Universities* at first sight meet the requirements imposed by their stakeholders when engaging in relationships with companies. A deeper view reveals that active links between univer-

sities and companies allow universities to gain knowledge about the approvability of their research. These links put them into a position where they can align their educational activities more with the demanded competencies. This said, it does not imply that universities are reshaping their research activities portfolio towards industrial style research, but that research projects are designed differently, taking into account professional research management approaches which are common practice in industrial research but less widespread and known in university research. In addition such feedback loops enable the discovery of additional science and technology issues and fields which deserve attention from university research.

3. *Both* universities and companies frequently find it easier to attract research- and innovation-related funding from public funding sources while demonstrating existing links and willingness to convert academic work into an application at some stage. This is a condition often found in announcements regarding the public funding of research and innovation activities in different shapes.

The task for universities upon entering partnerships with companies needs to reflect the experiences of companies in R&D and also in innovation partnerships. That is, when forming partnerships, universities can learn from the lessons of companies' partnerships which have been practiced for a long time. Among the core features of sustainable partnerships is a solid strategy formulation and explicit definition of the partner's contributions, obligations and rights, as well as reporting and decision making routines (Williams & Vonortas, 2015). Partners often enter into a partnership when the counterpart possesses valuable and multiple types of knowledge and recognized competences around which partnerships are formed (Hertzfeld & Vonortas, 2006). Frequently R&D cooperation is established by companies with various partners, but for similar motivations among which are R&D and innovation-related cost and risk sharing, avoiding the duplication of R&D activities, leveraging synergies as well as taking advantage of knowledge spillovers and accessing complementary resources and skills. In addition, it is assumed that cooperation in early technology development stages is a means of improving a company's position for developing and diffusing standards in technology fields (Hemphil & Vonortas, 2003). It is extremely important that entrepreneurial universities are aware of the motivations and agendas of companies, both actual and hidden, before entering into cooperation with them to limit the risk of diverging intentions and motivations in the long term and possible failure resulting from this divergence.

5. CONCLUSIONS

Over the course of the last few decades, entrepreneurial style universities have increasingly emerged and have begun to challenge traditional government policies to modernize. While policies often have traditional approaches and instruments, these seem not to be the most effective in maximizing national benefits from open global knowledge, technology and innovation markets, and networks. Instead of established policy instruments which are most often reactive (e.g., responding

to changing environments), policy is now challenged by actively supporting developments. This pushes policy makers to develop a vision for an overarching national innovation system and set priorities to eventually promote linkages within and between innovation ecosystems at the national and regional levels. Another important objective should be the improvement of the framework conditions for innovation, including dedicated infrastructure namely in the sphere of public research which is understood as one important issue to retain or attract science, technology and innovation related investments and talent.

The entrepreneurial university model provides a valuable overarching view on the role and meaning of universities for the national innovation system. It shows similarities with the open innovation paradigm, which has become widespread among companies. A recent OECD study (OECD, 2013) finds that many OECD countries are reflecting upon their national policy efforts toward linkages between universities and companies in the light of open innovation. Until recently, such policy measures were mainly targeting the commercialization activities of public research by means of supporting networks and markets for transferring and commercializing the results of public research. However, these approaches and models face considerable limitations. These include a narrow focus by employees on only research and teaching related positions as knowledge and technology owners and hence inventors; the natural, physical, and engineering sciences as primary sources of knowledge and technology, and patenting, licensing, and spin-off companies as transfer channels. There is also an apparent mismatch between the supply and demand of public sector knowledge and the continued lack of financing for university originated new ventures (Cervantes & Meissner, 2014).

These barriers also persist due to limited evidence and metrics for assessing changes in the whole ecosystem, not only at the university level but also with regard to relationships between actors at other levels. Accordingly, policy interventions are in many cases based upon anecdotal evidence rather than solid evidence. One might argue that episodes do arise from a broader phenomenon, thus policy makers are correct to aim at providing the grounds, via anticipatory policy, for designing a more supportive environment. However, policy initiatives have until recently rarely taken into account factors including ongoing organizational changes, strategic developments and orientations, and the intensity and shape of transfer channels. Governmental and institutional support for new models of linkages between universities and companies will have to ensure quality and sustainability by provisioning adequate rewards to all who contribute to education, research, and application or implementation efforts.

Despite the ongoing discussions of “entrepreneurial” and “open innovation” induced attitudes of universities and companies, the initiation and maintenance of relations between universities and companies remain determined by the supply and demand for technology and knowledge which each institution can foster. Therefore, existing organizations and their external interfaces need to shift according to knowledge and technology supply and demand (development) as well as to framework conditions (Kroll & Schiller, 2010). A broader understanding of the evolution of innovation eventually shows that innovation ecosystems may be characterized by fragmentation and isolation

(Gokhberg & Meissner, 2013; Meissner 2014). Despite cultural and geographic boundaries, information and knowledge flows freely across borders implying a need to overcome thinking in terms of national innovation systems which poses a challenge to national policy interventions. All actors need to contribute to an approach to an idea of networks, which have global reach but are increasingly interconnected and accessible. It is increasingly important for governments to understand the nature and extent of these networks (Cervantes & Meissner, 2014; Tether & Tajar, 2008).

For entrepreneurial universities to perform well in the Triple Helix context, current and former students are valuable multipliers and links to act as key actors in the exploitation of new knowledge and technologies. Acknowledging this role, and understanding the driving factors and underlying challenges are essential in order to develop a promising sustainable strategic vision for future entrepreneurial university orientation. An entrepreneurial university publicly acknowledges the role and importance of graduates as the institutions' ambassadors, but also as resources for the future positioning and development of the university. Furthermore, the entrepreneurial university recognises the complexity of linkages with companies and governments; these are driven by the content shared by the partners, reflect the unique offerings and competences of each yet are constrained also by their research and innovation culture. In addition, building and maintaining linkages between universities and companies needs to take account of the relatively short time horizon of industry, in comparison to the academic world. Finally, they need to consider the fact that switching partners is a common procedure for companies and that the ongoing assessment of the price/quality ratio of the relationship and elements of the transfer process such as project management, project milestones kept, and budgets is standard (Lawrence & Kirk, 2007).

This article reviewed the understanding of an entrepreneurial university and its meaning for universities as institutions, university employees and stakeholders in light of the challenges arising from the Knowledge Triangle and the Triple Helix model. It showed that the concept of an entrepreneurial university is well suited for empowering universities to contribute value to society and the economy if fully embraced. In order to do so, it is necessary to expand the predominant perception of the concept of 'entrepreneurial university' and the inherent limitations on technology commercialization.

Applying the broader implications as outlined suggests that the predominant evaluation schemes of researchers, teachers and universities as well as those of science, research and innovation funding need to be redeveloped in order to support development of the entrepreneurial university. The question of how university employees can be incentivized to create the entrepreneurial university and to participate more fully in knowledge and technology transfers and commercialization could be another interesting avenue for future work. This has to take special account of informal contacts with reference to consulting and research collaboration especially because these channels are hardly visible, yet they are important to stakeholders. Understanding university employees' involvement in these channels needs more attention to their mindset, motivations and competences, and recognition of the institutional culture and leadership in which they are embedded.

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