Technological Forecasting & Social Change 111 (2016) 31–43

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Teams' boundary-spanning capacity at university: Performance of technology projects in commercialization

Mozhdeh Taheri, Marina van Geenhuizen *

Faculty of Technology, Policy and Management, Delft University of Technology, Jaffalaan 5, 2628 BX Delft, The Netherlands

ARTICLE INFO

Article history:
Received 11 February 2015
Received in revised form 13 February 2016
Accepted 4 June 2016
Available online 1 July 2016

Key words:
Universities
Technology projects
Commercialization
Collaboration
Co-creation
Boundary-spanning
The Netherlands

ABSTRACT

Universities increasingly are taking on the commercialization of knowledge as their third mission. More recently, they appear to be challenged to go even beyond that mission and adopt more interactive relationships with user groups and society. A shift like this calls for a solid study on how well the knowledge commercialization has performed at university in recent years. Focussing on a European country, the Netherlands, this paper provides a characterization of that performance and the underlying factors, and in particular the boundary-spanning capacity of university teams. In an analysis of trends in commercialization, involving almost 370 university-driven technology projects, we observe that 22% of all older projects succeed in market access within ten years after start of the project. For younger ones, this is 15% of all projects within 5 years after start. To clarify these possibly low levels, a rough-set analysis of about 40 technology projects is carried out, pointing to the years of collaboration with a large firm/user organization and an efficient use of resources as positive influences on commercialization, while affinity among project managers with the market also tends to be a key factor. Despite a general trend of more permeable university-industry boundaries, it deserves recommendation to further increase boundary-spanning activities, among other things through co-creation labs.

1. A more prominent and engaged role of universities

1.1. Early engagement and third mission

It is widely recognized that developments in the 1990s and 2000s, both in the US and Europe, including measures that regulate intellectual property rights, increasing relevance of university research and its practical translation (industrial/societal problems), a larger availability of funding resources, etc., have led to a more direct involvement of universities in the business community (Mowery et al., 2004; Etzkowitz, 2008; Geuna and Muscio, 2009; van Looy et al., 2011; Abreu and Grinevich, 2013; Perkmann et al., 2013).

The first involvement of universities in knowledge commercialization (contract research) dates back to the beginning of the last century, with the establishment of John Hopkins university and hospital in the US (Feldman et al., 2014). This involvement continued during World War II, mainly through military applications, for example the development of the first nuclear weapons, the Manhattan project in 1940s, and the development of the first computers at Oxford (Copeland, 2006) and Manchester University in 1947 (Lavington, 1998). However, the systematic involvement of universities in contract research and other types of knowledge commercialization is a recent development, that started in the 1980s and continued in the 1990s (Rasmussen et al., 2006). As a result, nowadays, universities are not only seen as educational institutes and creators of new knowledge, but are involved in a wide set of activities of knowledge commercialization, denoted as their 'third mission', a mission that encompasses contract-research commissioned by the business sector, collaborative technology projects with business partners, the licensing of university patents and the creation and nurturing of spin-off firms (Shane, 2004; D'Este and Patel, 2007; Huggins and Johnston, 2009; Loi and Di Guardo, 2015).

In Europe, this new role of universities started to develop since the mid-1980s (Charles and Howells, 1992), and included the establishment of science parks designed to attract existing technology firms for collaboration with universities, an initiative that was mainly originated externally (Rasmussen et al., 2006). Since the mid-1990s, initiatives typically became based on more internal drives at university, for instance the establishment of spin-off firms by graduates and staff, and patenting/licensing. As a result, today, a wide spectrum of motives and modes/channels of transfer and commercialization is part of the research policy of 'entrepreneurial' universities, and this activity is officially considered one of the tasks of universities (Etzkowitz, 2008; Hussler et al., 2010; Rasmussen and Borch, 2010; van Looy et al., 2011; Martin, 2012). For example, in the Netherlands, the commercialization of knowledge was officially recognized as the 'third mission' in

* Corresponding author.
E-mail addresses: m.taheri@tudelft.nl (M. Taheri), m.s.vangeenhuizen@tudelft.nl (M. van Geenhuizen).

http://dx.doi.org/10.1016/j.techfore.2016.06.003
0040-1625/

2008, and it has been substantiated in a national policy program called the 'Valorization program' (Innovation Platform, 2009). As a result, today, the main issue is to improve the performance of existing transfer structures and processes (Mustar et al., 2008; Geuna and Muscio, 2009; Bruneel et al., 2010; Gilsing et al., 2011; Núñez-Sánchez et al., 2012; van Geenhuizen, 2013; Todeva, 2013).

The term knowledge commercialization, as used in this paper, is the "process of creation of value from knowledge, by adapting it and/or making it available for economic and/or societal use, and transform it into competing products, services, processes and new economic activity" (Innovation Platform, 2009, page 8). Knowledge commercialization is a stage-based process that starts with initial ideas about practical application and market introduction, sometimes in collaboration with a large firm, and about steps to realize that market introduction through various channels (Bekkers and Bodas Freitas, 2008; D'Este and Patel, 2007). Essentially, knowledge commercialization at university requires the bridging of different 'worlds'- science, business and eventually user groups — and accordingly it involves various boundary-spanning activities.

1.2. A more prominent engagement and 'Open Science'

A new development is the more prominent position adopted by the public sector, citizens and civil society in university research, requiring a stronger social engagement on the part of universities (e.g. Breznitz and Feldman, 2012). This development is part of an ongoing evolution in the way research is conducted and science is organized, that started with the development of the so-called science shops in The Netherlands in the 1970s. Science shops linked university researchers to civil society organizations in a broader attempt to democratize both science and society. Subsequently, science shops spread throughout Europe and now constitute a network of intermediaries between university and various societal groups (Schlierf and Meyer, 2013).

'Open Science' (or 'Science 2.0') today is a holistic approach towards science-related processes, ranging from framing of problems, conceptualization of research ideas and data gathering and analysis, to the publication and use of scientific outcomes (EC, European Commission, 2014; EC, 2015a). The aim is to make research more open, global, collaborative, creative and closer to society, through the use of ICT tools, media and networks. Accordingly, citizens and society participate as contributors and direct beneficiaries of new knowledge. Citizens' engagement ranges from being better informed about research to participating in the scientific process itself, including observing, gathering and processing data, as well as funding research and developing ideas on innovation. Compared to the past, 'Open Science' encompasses a significant increase of scientific production, data-intensive science and an increase in the number of stakeholders in science, which enable interactive processes of co-creation and knowledge commercialization. This development is specifically important when it comes to finding solutions to persistent social (sustainability) problems in cities (Goddard and Vallance, 2013; Trencher et al., 2014), mainly in areas that are closely related to people's health and lifestyles, energy, daily living (environment), work, transport, etc. Note that various organizations in Europe were already involved before the label of 'Science 2.0' was launched. For example, the Frauenhofer Institute for Systems and Innovation Research (Germany) has been exploring user-centred innovation since 2010, including the co-development, co-testing and co-evaluation of sustainability and quality-of-life solutions (Living labs), while, in 2012, the University of Manchester (UK) launched the University Living Lab initiative to transform its campus into a site of applied teaching, research and experimentation (co-creation) with users in everyday circumstances (Evans et al., 2015; Voytenko et al., 2015).

Overall, it would appear that, with the introduction of 'Open Science', a set of weakly addressed and understood issues will arise, as already indicated by results from public consultation in Europe (EC, 2015a), and these are issues that also appeared in some earlier commercialization studies. They involve barriers at institutional level and individual level of scientists, including a limited awareness regarding 'Open Science', uncertainty about benefits and about quality assurance, etc., all reinforcing the need for boundary-spanning activity.

1.3. A focus on university-driven technology projects

Among the channels involved in knowledge commercialization, technology projects at universities have attracted relatively little attention in existing literature (D'Este and Patel, 2007; Gilsing et al., 2011), with the exception of Barnes et al. (2002), who emphasize good practice in the management of university-industry collaborations, Fontana et al. (2006), Santoro and Bierly (2006) and Bruneel et al. (2010), who study the determinants of research collaboration or facilitators of knowledge transfer from the side of *firms*, while Bekkers and Bodas Freitas (2011) examine university-industry projects, with an emphasis on organizational structures affecting the outcomes of the collaboration. These studies suggest that collaboration experience, social connectedness and trust between university and industry, as well as a university's intellectual property policy and technological capability and relatedness, may reduce barriers and facilitate the transfer of knowledge. However, there is a lack of understanding as to how such factors at university influence projects reaching the market and the time involved (Perkmann and Walsh, 2007). Very little is known about the timing of reaching the market among others under the influence of boundary-spanning capacity of research teams at university, for instance, the affinity of research managers with the market and their experience in collaboration. The relative lack of understanding of the performance of knowledge commercialization at universities (e.g. through contract research) may harm the future development of active co-creation models in a wider societal engagement. Accordingly, the current study limits the focus on universities and their research teams.

Given the knowledge gaps outlined above and given the changes universities need to make to go beyond the third mission, we address the following questions in this paper:

(1). (a) To what extent do technology-based projects at universities manage to reach the market (including societal use)? (b) What are the time lines involved?
(2). What are the capacity factors at universities and what are the external factors that affect the outcomes of commercialization performance?

The Netherlands are studied as an example of a specific group of European Union countries that, in recent years, have been facing the so-called 'knowledge paradox' of a high R&D input and a low innovation output (or growth), a group that includes Norway, Sweden, Austria and parts of United Kingdom (Audretsch and Keilbach, 2007; Bitard et al., 2008; ProInno Europe, 2012). The paper is structured as follows. Model building, concerning factors that are expected to influence the commercialization outcomes, is discussed in Section 2. Section 3 deals with methodological and measurement-related issues. In Section 4, the empirical results are highlighted: 1) descriptive results on outcomes of commercialization lines (trends), 2) results on factors influencing commercialization outcomes (rough-set analysis), and 3) case studies. Section 5 provides the conclusions and recommendations for policy-making and future research.

2. Factors affecting knowledge commercialization

2.1. Introduction

Knowledge commercialization among universities, business world and user groups, cannot succeed without boundary-spanning activities