

# Nurture over nature: How do European universities support their collaboration with business?

Victoria Galán-Muros<sup>1,2</sup> · Peter van der Sijde<sup>1</sup> ·  
Peter Groenewegen<sup>1</sup> · Thomas Baaken<sup>2</sup>

Published online: 22 October 2015  
© Springer Science+Business Media New York 2015

**Abstract** Higher Education Institutions (HEIs) have been placed at the core of regional innovation ecosystems and encouraged to contribute to the social and economic development of the communities where they operate. In response to this change in the environment, HEIs have faced the need to adapt their organisational culture, practices and structures. In spite of the acknowledged relevance of university-business cooperation (UBC) as a source of HEI competitive advantage, and the recognition that appropriate interventions or supporting mechanisms can effectively foster UBC, there is still little systematic understanding of organizational mechanisms in the HEI management of UBC. In order to fill this gap, this paper identifies and evaluates the mechanisms that European HEIs are using to nurture industry collaboration at strategic and operational level and assess their relationship with seven UBC activities. With a sample of 2.157 HEI managers in 33 countries, the main results highlight the importance of the combination of support at both strategic and operational levels and the core role of the management commitment for all UBC activities. The paper concludes with the contribution to theory and the relevant implications for UBC managers and policy makers.

**Keywords** University-business cooperation · Strategies · Structures · Incentives · Organisational culture · Knowledge transfer

---

✉ Victoria Galán-Muros  
galanmuros@fh-muenster.de

Peter van der Sijde  
p.c.vander.sijde@vu.nl

Peter Groenewegen  
p.groenewegen@vu.nl

Thomas Baaken  
baaken@fh-muenster.de

<sup>1</sup> Vrije Universiteit Amsterdam, De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands

<sup>2</sup> Science to Business Marketing Research Centre, Münster University of Applied Sciences, Correnstraße 25, 48149 Münster, Germany

**JEL Classification** L2 · I23 · O32

## 1 Introduction

The current structure of organisations is partly dependent of the external environment at the moment of their foundation (Stinchcombe 1965) and higher education institutions<sup>1</sup> (HEIs) are not an exception. The original medieval HEIs were created as houses of knowledge and their structure was the most efficient one at that point to deliver education. As organisational forms get institutionalised and tend to remain remarkably stable across time (Stinchcombe 1965), so HEIs barely changed some of their core structure for centuries.

However, politically induced institutional changes occur, like those induced by new interest groups (Stinchcombe 1968) and in the case of HEIs, they were asked in the 1800s to respond to societal changes such as the industrial revolution (Etzkowitz 2001). From the initial mission of education, HEIs underwent their first radical change as they added a second mission, research.

With research as the second mission, HEIs developed a strong research driven focus compared to other HEIs (Clark 1995). A new wave of HEIs was founded from the mid-1850s onwards. Various changes in HEI structure accompanied these developments such as: initiation of scientific research as a dedicated mission of the HEI; organisation of research into academic faculties and departments to reflect the academic self-organisation of disciplines. Also facilities to accommodate research such as laboratories were established, nurturing this new mission.

Not all of these changes took place in exactly the same way in each institutional environment, for instance in agriculture (Busch and Lacy 1983) and engineering research (Servos 1980) some HEIs were driven by practical and economic motives from the start. Also the “imprinting” of this new wave of foundations and change can be regarded as imprinted by new imperatives also changing older HEIs (Stinchcombe 1968). Thus, HEIs were in general after introduction of the research mission devoted to provide both education and research with the ideal of HEI itself adapted to embrace this second mission (Wissema 2009).

More recently, the HEI underwent its second major transformation as knowledge transfer becomes the HEIs third mission (Etzkowitz and Leydesdorff 2000; Wissema 2009). Especially, since the 1980s, HEIs have been under pressure from governments and societal forces to actively contribute to the social and economic development of their regions (Guerrero et al. 2015) and to take a prominent role within national and regional innovation ecosystems (Goddard and Chatterton 1999; Slaughter and Rhoades 1996). In 1980, the Bayh–Dole Act, which offered HEIs the possibility to get ownership of inventions made with federally funded research, marked an inflection point in in the US HEI management and internal structures to accelerate the process and support academic entrepreneurship (Grimaldi et al. 2011).

In the face of an increasingly changing world economic environment and the rapidly changing needs of business, even further momentum is being placed on HEIs to contribute through this third mission with the increase in organised collaboration with business as a core tenet in this movement (Shane 2004). As this third development gained momentum,

---

<sup>1</sup> Understood in this paper as synonym of university.

the modification of the HEI organization led to a wider diversity of structures to nurture the three missions, such as technology transfer offices (TTOs) (Aldridge and Audretsch 2011), incubators (Rothaermel and Thursby 2005). Moreover these missions took place when the diversity of national regulations spurred differentiation (Teichler 2008).

The three HEI missions need to be connected (Goddard and Chatterton 1999) and university-business cooperation (UBC) is the transversal concept that glue them together and connect them with the outside environment, keeping education, research and valorisation relevant for society. However, these new demands call for a re-examination of HEIs' organisational structures and practices (Siegel et al. 2003a, b), including traditional HEI management systems, which might not be appropriate to deal with rapid decision making and R&D commercialisation activities (Siegel et al. 2007b). Moreover, the changes in organizational features might be more or less complete depending on the type of institution, field and national environment (Enders 2004; Teichler 2008). Thus the integration of the third mission might be shaped differently under different conditions and its organizational development uneven.

Despite the recognised relevance of UBC as a source of HEI competitive advantage (Shane 2004), and the recognition that appropriate interventions or supporting mechanisms can effectively foster UBC (Fini et al. 2011; Santoro and Gopalakrishnan 2000; Tornatsky et al. 2002), there is still little systematic understanding of organizational mechanisms in the HEI management of UBC. Examining the organisational mechanisms driving the organisational processes relays on contributes to shed more light into how organisational activities occur (Pajunen 2008). Even when organisational mechanisms are commonly studied in industry, the HEI literature is scarcer, and mostly focused on the research and teaching missions.

In order to fill in this gap, this paper first identify, classifies and evaluates mechanisms that European HEIs are using to nurture industry collaboration (support by the top management of the HEI, incentives for academics to be involved in UBC, the role of several offices to support academics to get involved in UBC, and the organisation-wide promotion of UBC). Secondly, a research question is posed: what is the relationship of the UBC supporting mechanisms with the development of UBC activities (in European HEIs)?

As opposed to UBC literature focused on the individual level, such as personal relationships (Plewa et al. 2013), motivations (Tartari and Breschi 2011), barriers (Muscio and Pozzali 2012), etc. or literature on the ecosystem level, like the triple helix (Etzkowitz and Leydesdorff 1997), or regional innovation ecosystems (Goddard and Chatterton 1999), this approach reveals the equally important organisational perspective on UBC, where both top-down and bottom-up approach have been found to be necessary and complementary (Polt et al. 2001; Rasmussen et al. 2006). Specifically, this paper shows whether the currently mechanisms nurtured by European HEIs are actually developing UBC activities and thus changing the natural path of HEIs, traditionally away from markets.

This study contributes to the UBC research field by increasing the understanding and recognition of the role of organisational support in the UBC success, in other words, how HEIs' are successfully nurturing UBC over their nature of education and research organisations. Additionally, this study contributes to the UBC practice (in Europe), highlighting the importance of stimulating and actively supporting UBC at organisational level while indicating to which UBC activities are affected by the different mechanisms, calling for resource re-allocation to the priority areas and further coordination to create competitive advantages.

## 2 Theoretical framework

### 2.1 The concept of university-business cooperation

UBC has been understood and defined in different ways. Traditionally, interest for UBC focused on the commercialisation areas of collaboration including patents, licenses, spin-offs and spin-offs, involving primarily a unidirectional flow of knowledge (D'Este and Patel 2007). However, more recently there have been calls for a broader concept of UBC in order to capture the value that HEIs contribute to business and society (Hughes 2006; Davey et al. 2011; Klofsten and Jones-Evans 2000), which is reflected in studies by Lamichhane and Sharma (2013), Teixeira and Mota (2012) and Kitagawa and Lightowler (2013). Thus current studies give greater attention to forms of education-related UBC (Caniëls and van den Bosch 2011), a domain that was only infrequently discussed, even although education is the oldest HEI task. Also informal knowledge 'spill-overs' are increasingly recognized (Bekkers and Freitas 2008).

In this study, UBC involves any type of cooperative interactions between HEIs and the world of business for mutual benefits and is broadly understood as being integrated in the three main tasks of the HEI (Goddard and Chatterton 1999): education, research and valorisation. Informal contacts such as meeting at conferences and fairs (Grimpe and Fier 2010), although very important, are not considered UBC activities in this paper, but precursors of cooperation (Plewa et al. 2013).

In the *education* domain, HEIs benefit from the exposition to and collaboration with industry to create opportunities for student mobility, tap into the needs of industry to get involved in lifelong learning as well as the involvement of the business world in the design and delivery of (parts of) the curriculum. In the *research* domain, HEIs offer research knowledge to business through academic mobility and joint R&D actions. In the *commercialisation* domain, HEIs enter the market with the creation of spin-offs and start-ups or provide knowledge to industry (via patents and licences). A summary of the domains and activities is presented in Table 1, following the research of (Davey et al. 2011).

### 2.2 The UBC mechanisms of Higher Education Institutions

There is enough evidence that the organizational, regulatory and working environment all have an effect on the academics' UBC engagement, as shown for technology transfer (Bozeman et al. 2013; Nilsson et al. 2010). These so-called "institutional frameworks" can be improved directly by the HEI management *or* indirectly by the governments with policy that encourages the transformation or improvement of those mechanisms (OECD 2002). Contrary, a lack of supportive HEI strategies, resources, plans, reward and promotion systems has been mentioned as 'disincentives' to some UBC activities, like R&D commercialisation (Yencken and Ralston 2005). When reviewing and classifying the literature on UBC supporting mechanisms within the HEI, two underlying levels emerged (strategic and operational), and although both levels are related, mechanisms are distinguished according to these two levels. At the strategic level, the support of the management of the HEI and incentives are identified, while the operational level includes the UBC offices and UBC organisational promotion.

**Table 1** Summary of the UBC domains and activities

Domain	Activity	Definition
Education	(1) Joint curriculum design and delivery (CDD)	The joint development of a fixed programme of courses, modules, majors or minors, planned experiences as well as guest lectures by delegates from external organisations within undergraduate, graduate or PhD programmes
	(2) Lifelong learning (LLL)	The provision of adult education, permanent education and/or continuing education involving the acquisition of skills, knowledge, attitudes and behaviours by HEIs to people employed by external organisations
	(3) Student mobility (SM)	The temporary movement of students at all levels from HEIs to business
Research	(4) Professional mobility (PM)	The temporary movement of teaching staff or researchers from HEIs to business; and employees, managers and researchers from business to HEIs
	(5) Joint R&D	Includes joint R&D activities, contract research, joint R&D consulting, cooperation in innovation, joint publications with firm scientists/researchers, joint supervision of theses (Bachelor, Master or PhD) or projects in cooperation with business
Valorisation	(6) R&D commercialisation of joint R&D (COM)	The entry of scientific research and technologies in the market through the trading of intellectual property assets (disclosures of inventions, patenting, licenses or others) or spin-offs
	(7) Entrepreneurship (ENT)	The creation of an entrepreneurial culture or start-ups by HEI students or academics

Source: Table adapted from Davey et al. 2011

### 2.2.1 Strategic level: top management support of UBC

In order to contribute to the development process in the environment, HEIs require new strategic choices that enable them to quickly respond to changes (Goddard and Chatterton 1999), developing an institution in which UBC is supported and encouraged for all stakeholders, specially academics (Ambos et al. 2008; Geissler et al. 2006; Loi and Di Guardo 2015). HEI management consequently promotes the ‘third mission’ by creating and implementing strategies to encourage and support UBC activities (Gulbrandsen and Slipersaeter 2007). Their commitment includes establishing long-term strategies and an inclusive strategic approach directed at industry interaction (D’Este and Patel 2007; Siegel and Phan 2005). For example, Phan and Siegel (2006) found HEIs that generate the most start-ups are those that establish well-defined and clear spinout strategies. A mechanism used in top management to institutionalise the relevance of UBC is the presence of business people on the HEI board and the presence of academics on company boards (Wilson 2012), with this mechanism, HEIs guarantee that their education and research is going to remain relevant for the society. The practice of hiring people from outside the academic environment (e.g. employing CEOs, former CEOs or people with business mindset in faculties, departments, etc.) will build strong entrepreneurial capacities within the HEI (Lubango and Pouris 2007). However such adaptations are not universal and HEIs develop different interpretation of the values associated with UBC (Loi and Di Guardo 2015).

Since, many of the changes required in order to become an entrepreneurial HEI involve top management intervention, a way that guarantee that UBC is discussed at the highest level of the HEI is to have a board member or vice rector positions for UBC (Korff et al. 2014) in charge of officially preserving the relevance of UBC. However, top-down approach would not be successful enough by its own without incorporating the academics and students in policy formulations (Ponomariov 2008; Polt et al. 2001; Rasmussen et al. 2006). Moreover such connections need to be subtle enough to allow academics to adhere to their preferred role as academics (Jain et al. 2009).

**HI** The extent of management support to UBC in HEIs significantly affect the development of (a) joint curriculum design and delivery, (b) lifelong learning, (c) student mobility, (d) professional mobility, (e) joint R&D, (f) entrepreneurship and (g) R&D commercialisation.

### 2.2.2 Strategic level: incentives for UBC

Nowadays, UBC still occur in an informal basis in most cases, grounded in academics' personal initiatives, thus the results of academics' efforts depend on their alignment with the HEI rewards and incentives programmes (Grimaldi et al. 2011). Therefore, given the fact that academics as any other workers respond to incentives in place (Lach and Schankerman 2003) in line with the expectancy theory (Vroom 1964), UBC can be institutionalised with the establishment of incentives programmes. Incentives often rely on the dedication of resources, which for UBC range from technical, to social, human, and financial (Phan and Siegel 2006), although monetary aspects play a minor role (Lam 2011), since academics engage in UBC mostly for recognition (Göktepe-Hulten and Mahagaonkar 2009).

Resources have been provided mainly for intermediaries or boundary-spanning positions (Thompson et al. 2006), for qualified supporting staff (Tornatsky et al. 2002) and for supporting training (Mitton et al. 2007). The amount of dedicated UBC resources has proven to improve UBC success such as higher start-up rates and research based IPOs HEI (Phan and Siegel 2006).

Incentives are a well-known mechanism to develop UBC (Frey and Neckermann 2008; Stephan 2008). Those HEIs that engage externally are more likely to have incentive systems to reward that behaviour (Tornatsky et al. 2002). However, there is a lack of incentives to engage in interdisciplinary research collaboration, including industry, as opposed to disciplinary research collaboration (van Rijnsoever et al. 2011) and the current professional incentive system generally emphasize publishing in high impact journals and acquiring grants (vs. applied or translational research), which is "diametrically opposed" to potential knowledge transfer (Mitton et al. 2007). Therefore in order to engage academics a new mix of criteria for their evaluation is necessary, beyond the commonly referred research and teaching outcomes (Plewa et al. 2006).

For that reason, many authors have called for the need of a (better) system of incentives/rewards in order to improve: the inventive outputs of the HEI (Mathieu 2003; Lubango and Pouris 2007), the entrepreneurial character of the HEI (Henrekson and Rosenberg 2001); researchers' mobility (OECD 2002); faculty involvement in TT (Friedman and Silberman 2003; Grimaldi et al. 2011; Siegel et al. 2004); research R&D commercialisation (D'Este and Perkmann 2011; Lam 2011; Link and Siegel 2005); faculty's involvement in entrepreneurial activities (Friedman and Silberman 2003; Henrekson and Rosenberg 2001; Rothaermel et al. 2007; Thursby et al. 2001). Link and Siegel (2005) and Dottore et al.

(2010) highlight the importance of the incentive system to be coherent with other policy instruments, while other call for the need to embrace a combination of non-monetary and monetary incentives (Yencken and Ralston 2005).

UBC engagement as a criteria in the academics' evaluation system for promotion/tenure connects directly to academic motivation (Polt et al. 2001; Siegel et al. 2007a; Tornatzky et al. 2002). For example, the inclusion of commercialisation and UBC achievements in HEI promotional systems seem to increase academics' engagement (Plewa et al. 2006; Yencken and Ralston 2005). In terms of who should be incentivised, specifically for encouraging invention disclosures and commercialising, faculty are normally the ones to receive/benefit from the incentives/rewards directly (Debackere and Veugelers 2005; Friedman and Silberman 2003; Henrekson and Rosenberg 2001; Thursby et al. 2001) although rewards given to technology transfer staff have also been positively associated with the HEIs entrepreneurial activity (Lockett et al. 2005).

**H2** The extent of UBC incentives in HEIs significantly affect the development of (a) joint curriculum design and delivery, (b) lifelong learning, (c) student mobility, (d) professional mobility, (e) joint R&D, (f) entrepreneurship and (g) R&D commercialisation.

### 2.2.3 Operational level: UBC Offices

Organizational structure is closely connected with firm size and impacts its ability to adapt to the environment, create and assimilate knowledge, and be innovative (Santoro and Chakrabarti 2002). Also organizational structure affects knowledge and technology transfer as both involve detecting suitable sources, interacting with them, acquiring knowledge and/or technology and integrating them into current organisational procedures and systems (Santoro and Chakrabarti 2002). Innovate companies with relevant structures are more likely to collaborate with HEIs (Kruss et al. 2011; Santoro and Chakrabarti 2002). The question is whether this is also true for HEIs.

Most literature recommend HEIs to create transdisciplinary and heterogeneous structures that complement each other and involve the whole organisation, as well as hybrid units as an interface for collaborating with industry and other HEIs (Gibbons et al. 1994; Sporn 2001). Incubators are one of those structures, which support the development and maturation of novel technology and solutions (Rothaermel and Thursby 2005), acting as a showcase (Etzkowitz 2001; Ssebuwufu et al. 2012) and platform for spin-off creation (Dottore et al. 2010).

Of these hybrid units, TTOs are the most researched structure and have proven to be needed to support technology transfer (Aldridge and Audretsch 2011; Roges 2002). Studies in the USA show that organisational practices in respect to the TTOs considerably affect the variation in HEIs productivity (Siegel et al. 2003b). However, some studies find the role of the TTO in increasing the entrepreneurial activities of academics minimal (Clarysse et al. 2011) or even negative for collaboration (Feller and Feldman 2010).

**H3** The extent of development of UBC offices in HEIs significantly affect the development of (a) joint curriculum design and delivery, (b) lifelong learning, (c) student mobility, (d) professional mobility, (e) joint R&D, (f) entrepreneurship and (g) R&D commercialisation.



### 2.2.4 Operational level: UBC promotion/communication

One of the most common ways of promoting UBC at the highest level of the institution is to include it as a central part of the HEI mission (Friedman and Silberman 2003; Markman et al. 2004; Polt et al. 2001), which emphasize the desired behaviour (D'Este and Patel 2007; Grimaldi et al. 2011). Additionally, in order to encourage an environment that support UBC, HEIs often give attention to UBC topics in the media inside the HEI and in their respective regions or countries as well give official recognition to the “UBC Champions” with awards or special events (Tornatsky et al. 2002). Some HEIs also promote business and managerial cultures and skills amongst researchers through workshops in order to improve their chances of successful valorisation (Lubango and Pouris 2007).

As part of the UBC development, UBC need to be promoted through internal and external communication. The purpose of UBC promotion can be to communicate some opportunities within the HEI and externally (Korff et al. 2014), raise the importance of UBC activities or events (Geissler et al. 2006; Siegel et al. 2003a, b; van der Sijde 2012), stimulate effective links with the private sector (Lubango and Pouris 2007) and eventually to change or shape an entrepreneurial/collaborative culture.

**H4** The extent of UBC promotion in HEIs significantly affect the development of (a) joint curriculum design and delivery, (b) lifelong learning, (c) student mobility, (d) professional mobility, (e) joint R&D, (f) entrepreneurship and (g) R&D commercialisation. A summary of all the hypotheses (H1–H4) can be found in Table 2.

## 2.3 HEI characteristics affecting university-business cooperation

The four hypotheses developed are tested together in order to establish their mutual influence and to provide a comprehensive picture of UBC. However, all HEIs are not expected to behave in the same way as their characteristics may affect the degree of development of UBC of HEIs. Thus different types of HEIs engage with business differently; most of them emphasize the fact that applied fields have stronger HEI–industry ties compared to science-based fields (Arvanitis et al. 2008; Meyer-Krahmer and Schmoch 1998). Applied fields have a principal role in exploitation (Harryson 2008) and therefore receive more share of their funding from industry (Carayol 2003).

**Table 2** Summary of hypotheses

		In HEIs, the extent of UBC...			
		(H1) Management support	(H2) Incentives	(H3) Offices	(H4) Promotion
<i>...Significantly affect the development of...</i>					
(a) LLL	H1a		H2a	H3a	H4a
(b) CDD	H1b		H2b	H3b	H4b
(c) SM	H1c		H2c	H3c	H4c
(d) PM	H1d		H2d	H3d	H4d
(e) R&D	H1e		H2e	H3e	H4e
(f) ENT	H1f		H2f	H3f	H4f
(g) COM	H1g		H2g	H3g	H4g



Considering that those applied fields which are closer to the market are mostly located in polytechnics and HEIs of applied sciences, these type of HEIs are said to be more engaged with industry, also considering that they usually have more developed technology transfer policies than traditional HEIs (Perkmann et al. 2013; Renault 2006). Findings are confirmed from the industry perspective too, with those applied sectors in which technology is developing fast having the highest collaboration, like engineering (Bekkers and Freitas 2008) genetic engineering, pharmaceuticals and laser technology (Kaufmann and Tödtling 2001).

Regarding the HEI size, although there are not many studies in this respect, some suggest that the size of the HEI is also related with the degree of cooperation with business, like Van Geenhuizen (2010), who stated that the size of the research institutions, among others, was found to be relevant factors to determine the degree of knowledge valorisation. Smaller HEIs in the UK are more likely than larger ones to collaborate domestically, mainly with industrial partners and other HEIs, and this is probably related with the resource limitations of smaller HEIs (Katz 2000). However, larger HEIs also in the UK were also found to receive more knowledge exchange public funding per academic (Rossi and Rosli 2013) thus obfuscating the issue of size.

The HEI location might also relate with the development of UBC. The few international studies indicate a difference between countries (Davey et al. 2011; Kaufmann and Tödtling 2001; Klofsten and Jones-Evans 2000) with a diversity environments that can support and/or inhibit UBC (Geuna and Nesta 2006). Additionally, proximity to regions with concentration of high-tech firms enhances technology transfer (Friedman and Silberman 2003) and proximity to a science park increases the probability that the academic curriculum change from basic to applied research (Siegel and Phan 2005).

### 3 Methodology

#### 3.1 Data and data analysis

The data for this paper was collected in the framework of the European study “The state of European university-business cooperation”, which was conducted in the 33 countries of the European Economic Area. A comprehensive survey was designed to quantitatively measure the perceptions of HEI managers about UBC in their organisation; it was translated into 22 languages and was sent via email in 2011 to two HEI managers in each of the 3551 officially registered HEIs in those countries asking for further distribution within their organisation. For this reason the final number of managers receiving the survey is unknown. The survey addresses both academics and managers. In this paper, only the data collected from HEI managers (TTO/innovation office/incubators directors) regarding supporting mechanisms and UBC activities is used (Davey et al. 2011).

The study collected the responses (after data cleaning) of 2157 HEI managers from different types of HEI (including, traditional universities, universities of applied sciences, polytechnics). As the data was not representative by country, a weighting system was created and applied to adjust the number of responses per country to the real weight of that country regarding the current number of registered HEIs according to Eurostat data.

The data analysis was carried out using the statistical software package IBM SPSS 20 and started by reducing the dimensions of the items in a confirmatory factor analysis (see results in “Appendix”). This was made in order to empirically confirm the underlying

groups that emerged when reviewing and classifying literature on UBC mechanisms. Then, a series of tests were made to check that the data meet the assumptions of generalised linear models: (1) linearity; (2) normality of the residuals; (3) equality of residual variances; and (4) fixed independent variables measured without error. The data was found to meet all these assumptions and thus seven linear regressions were undertaken.

## 3.2 Variables

### 3.2.1 *Dependent variables*

There are seven dependent variables representing diverse UBC activities (see Table 1). The extent of development was measured using ten-point Likert scales, from 1 (“not at all”) to 10 (“to a very large extent”). Participants were provided with the definitions of each of the UBC activities, so that they could assess them accurately. The questions were: “Please indicate to what extent you cooperate with business in respect to... (1) joint curriculum design and delivery, (2) lifelong learning, (3) student mobility, (4) professional mobility, (5) joint R&D, (6) entrepreneurship, (7) R&D commercialisation of joint R&D results”.

### 3.2.2 *Independent variables*

The independent variables are factored variables (results of the factor analysis) of four HEIs mechanisms of UBC (see “Appendix”) whose extent of development was measured using ten-point Likert scales, from 1 (“not at all”) to 10 (“to a very large extent”).

- a. Top management support: Degree to which the HEI top management is committed to UBC, whether it is with positions for business people in the board, with their participation in company boards or through a top management specific position in charge of UBC.
- b. Incentives: Policy measures that encourage academics to engage, such as the dedication of resources to support UBC, the provision of incentives for academics to encourage UBC or the inclusion of UBC as part of the assessment of work performance for academics.
- c. Offices: Structures within the HEI that support UBC, such as: career offices, internal agencies dedicated to UBC or incubators for the development of new business.
- d. Promotion: Internal and external communication of UBC aimed at different stakeholders using diverse media and including a documented HEI mission and vision embracing UBC.

### 3.2.3 *Control variables*

This study control for three variables that are considered in literature to be relevant for UBC. This analysis eliminates the influence that these variables might have in the results to focus on the influence of the mechanisms alone.

- a. Type of HEI: HEIs are divided in four groups regarding their nature as traditional HEIs, HEIs of applied sciences, polytechnics and others.
- b. Size of HEI: based on the number of academics, HEIs in the sample are divided in three equal groups: small, medium and large.

**Table 3** Sample characteristics regarding the control variables

Location of HEI	(%)	Type of the HEI	(%)	Size of the HEI	(%)
Northern Europe	17.48	Traditional HEIs	53.8	Large	33.3
Western Europe	33.05	UAS	17.3	Medium	33.3
Southern Europe	20.40	Polytechnics	18.3	Small	33.3
Eastern Europe	29.07	Others	10.6		

- c. The location of the HEI: HEIs are divided depending the European region they are located (according to the UN classification of European regions) (Table 3).

## 4 Results

### 4.1 Model results: goodness of fit

Table 4 shows the R<sup>2</sup> of each of the equations, with all of them between 26.2 % for professional mobility and 45.4 % for entrepreneurship, which means a considerable explanation of the dependent variables in all cases. The results of the F test indicate that all independent variables in each equation significantly explain the dependent variables, so the models tested are all relevant.

### 4.2 Individual results: variables

Table 5 shows how most of the mechanisms are significantly related to most UBC activities and that the degree of association of each mechanism also varies for the different activities.

At the strategic level, the top management support of UBC is the only mechanism significantly associated with the UBC development of all seven activities. Moreover, top management support is the mechanism with the highest influence for joint R&D. Therefore, the seven hypotheses H1a–H1g are supported.

In respect to incentives, they are significantly related with the development of five UBC activities (joint curriculum design and delivery plus the research and valorisation domain). Contrary, student mobility and lifelong learning are not significantly related with incentives. Additionally, this mechanism is the one with the strongest association with the activities of joint curriculum design and delivery and professional mobility. Thus, hypotheses H2 (a) (d) (e) (f) and (g) are supported.

At the operational level, each of the mechanisms is significant with the development of five out of the seven UBC activities. The development of the UBC offices are significantly

**Table 4** Goodness of fit

	Education			Research		Valorisation	
	CDD	LLL	SM	PM	R&D	ENT	COM
F	29.163	24.675	25.166	21.578	45.176	50.865	45.913
R <sup>2</sup>	.324	.288	.292	.262	.426	.454	.432

**Table 5** Regressions on the seven UBC mechanisms

	Education						Research						Valorisation					
	CDD		LLL		SM		PM		R&D		ENT		COM					
	$\beta$	p value	$\beta$	p value	$\beta$	p value	$\beta$	p value	$\beta$	p value	$\beta$	p value	$\beta$	p value				
Intercept	2.243	.000	1.569	.000	1.785	.000	1.212	.000	2.553	.000	1.200	.004	1.588	.000				
Management	.195	.001	.252	.000	.117	.047	.218	.000	.291	.000	.240	.000	.188	.000				
Incentives	.276	.000	.079	.184	.063	.295	.267	.000	.120	.026	.177	.001	.198	.000				
Offices	.100	.035	.005	.919	.116	.017	.025	.600	.164	.000	.199	.000	.339	.000				
Communication	.143	.024	.328	.000	.344	.000	.083	.176	.116	.045	.235	.000	.038	.513				
HEI location		.000		.000		.012		.027		.000		.374		.001				
HEI type		.004		.720		.016		.130		.030		.000		.720				
HEI Size		.124		.704		.111		.770		.154		.497		.550				

**Table 6** Summary of the results

	In HEIs, the extent of...			
	Management Hypothesis 1	Incentives Hypothesis 2	Offices Hypothesis 3	Promotion Hypothesis 4
<i>...Significantly affect the development of...</i>				
(a) LLL	+	–	–	+
(b) CDD	+	+	+	+
(c) SM	+	–	+	+
(d) PM	+	+	–	–
(e) R&D	+	+	+	+
(f) ENT	+	+	+	+
(g) COM	+	+	+	–

(+) Means accepted hypothesis and (–) means rejected hypothesis

associated with the development of all UBC activities, except lifelong learning and professional mobility. Nonetheless, offices have the highest relation of all mechanisms for the R&D commercialisation. Hence, hypotheses H3 (a) (c) (e) (f) (g) are supported.

Communication is revealed as another important mechanism, significantly associated with the UBC level in joint R&D and entrepreneurship and the three activities within the education domain, and then non-significantly related with R&D commercialisation and professional mobility. It has an especially high connection with the education domain, being significantly related with its three and with the strongest relation of all mechanisms for lifelong learning and student mobility. Thus, hypotheses H4 (a) (b) (c) (e) (f) are supported.

In respect to the control variables, only their significance level are presented and not the degree of influence for each of the categories, since they are not the focus of this paper. Concerning their significance, HEI location is significantly associated with all the UBC activities, the size of HEI with none of the activities and the type of HEI is significantly associated only with joint curriculum design and delivery, student mobility, joint R&D and entrepreneurship. Finally, Table 6 summarises the results of each of the hypotheses of this study.

## 5 Discussion

Regarding the UBC activities associated with each of these mechanism, most of the mechanisms tested are significantly associated with most of the seven UBC activities, showing that HEIs that have high development of UBC, usually display a full set of different supporting mechanisms, at both strategic and operational level. However, looking at each of the activities, there are differences that sometimes contradicts previous literature and provide novel results.

At the *strategic level*, the result that top management support of UBC is significantly related with the UBC development of all seven activities aligns with previous literature, which emphasizes the importance of top management in the success of UBC (Ambos et al.

2008; Geissler et al. 2006) and the need of top–bottom approach complementing a bottom-up one (Rasmussen et al. 2006; Polt et al. 2001).

This result shows for the first time the significant relation of management support and the seven specific UBC activities, proving that no UBC can be developed without managerial commitment. Additionally, top management support is the mechanism with the largest influence on joint R&D, maybe because it is the most strategic activity (usually with longer negotiations and more managers involved) and in also in entrepreneurship, probably for the need of a high development of start-ups strategies (Phan and Siegel 2006).

The significant relation of incentives with the development of most activities supports the abundant previous literature in this topic (Frey and Neckermann 2008; Mitton et al. 2007; Stephan 2008; Tornatsky et al. 2002; van Rijnsoever et al. 2011), confirming that academics require to see the personal benefit of their engagement to do so. It should be highlighted that for incentives to be effective, they should be designed considering academics preferences. The strong association with joint curriculum design and delivery suggests the task of redesigning the curriculum with industry or bringing industry speakers to the lectures require time and effort that academics are not willing to take without some form of compensation.

The strong association of incentives with professional mobility might be because the decision of a temporary movement to industry is challenging enough, that academics would only do it if the right incentives are in place. Contrary, student mobility is not significantly connected with incentives because academics have been traditionally involved in this activity on a voluntary basis, with no expectations of anything in return. There is usually a specific office for this UBC activity. Lifelong learning is not significantly related with the incentives in place. This may be due to the fact that if academics get involved in lifelong learning this is either already part of their agreed teaching duties or is compensated by extra salary in all cases.

At the operational level, UBC offices, as the interfaces between an HEI and businesses, are one of the most studied mechanisms for UBC in literature. Its significant connection with five activities aligns with previous literature, which is mostly focussed in entrepreneurship and R&D commercialisation (Dottore et al. 2010; Nilsson et al. 2010; Roges 2002; Siegel et al. 2003b), the activities with which offices have the strongest association. Contrary, the connection specifically with the development of lifelong learning and professional mobility has not been tested in literature before, so the lack of significance of those connections are novel results.

The reason why lifelong learning is not significantly related with the development of offices might be because if lifelong learning is part of the normal teaching there is an educational office taking care. In the case of executive education, there might be a person or office responsible, but has not been included in the study. The reason why professional mobility is not significantly affected maybe because it mostly depends on whether this UBC activity is allowed or not by the HEIs and there is normally no office for this, but is rather dependant of the vice rector of teaching or research. Also, there is a low percentage of HEIs that have specific regulation for professional mobility, which makes it the less developed of the UBC activities.

Communication is significantly related with the UBC development in joint R&D and entrepreneurship and the three activities of the education domain, in line with previous literature (Friedman and Silberman 2003; Geissler et al. 2006; Korff et al. 2014; Lubango and Pouris 2007; Markman et al. 2004; Tornatsky et al. 2002; van der Sijde 2012). The strong relationship with the education domain might be because engagement there is less common and its promotion can make a big difference in the actual engagement.

Communication is not a significant influence on professional mobility because a very low percentage of European HEIs have specific regulation for professional mobility. It is the less developed activity thus its communication would not be large and even if the communication exists, without incentives to do so, academics would not engage. Additionally, communication might not be significant for R&D commercialisation since this activity is governed by market rules, this means that no matter how much R&D commercialisation is promoted within the HEI, R&D commercialisation only happens if the HEI research have enough market interest and potential. Communication might be a necessary but not a sufficient mechanism for R&D commercialisation.

Regarding control variables, the fact that the HEI location is significantly associated with all the UBC activities shows that the development of UBC can be partly explained by the region where the HEI is located. This result is in line with previous literature (Kaufmann and Tödtling 2001; Klofsten and Jones-Evans 2000).

HEI size is not significantly associated to the development of any of the UBC activities, which makes this UBC characteristic irrelevant for explaining UBC and contradicts the scarce previous literature (van Geenhuizen 2010; Katz 2000; Rossi and Rosli 2013). More and in-depth studies should explore this further. Finally, the result of the type of HEI, which is significantly related only with four of the seven activities, does not fully align with previous research that state that different types of HEIs have different UBC development. The main reason, in line with the discussion in the introduction, might be that in the last few years all HEIs have moved in a similar direction, towards an entrepreneurial HEI, minimizing the differences in some UBC activities. Controlling for these characteristics makes these results valid for all European HEIs, no matter the region, size or type.

HEIs with high development of UBC apply a set of mechanisms at both strategic and operational level simultaneously, which need to be aligned with the UBC activities (Henrekson and Rosenberg 2001). However, for UBC to be successful, not only HEIs need to have these mechanisms, but other actors of the UBC ecosystem (business, chambers of commerce, regional development agencies, etc.) should have them in place as well (Tornatsky et al. 2002; Johnson 2009).

## 6 Conclusions

HEIs and business have been collaborating for over a century, but the rise of a global knowledge has intensified the need to go beyond the traditional collaboration in discrete research projects and move some steps ahead. In order to support, nurture and institutionalise this collaboration, HEIs are required to adapt their internal organisation and put in place a series of new mechanisms at strategic and operational levels to integrate the collaboration into its missions.

Even when HEIs are generally slow changing organisations, closely committed to their original nature and with considerable resistance to change, HEIs are already adapting to their new role as engines of the knowledge society. Nonetheless, there is still little understanding of the way HEIs operate in this context and how they nurture and supports UBC at the different levels in the organization.

The research question: ‘what is the relationship of the UBC supporting mechanisms with the development of UBC activities (in European HEIs)?’ is addressed. Results show indeed most mechanisms are significantly associated with most UBC activities, because the



top management support is significantly related with all of them and incentives, offices and promotion are significantly associated with five out of the seven activities each.

Specifically, the significant relevance of the management support for all activities underlines the importance of the institutionalisation of UBC and its nurturing and recognition at the highest level. Without management support, UBC is not developed in European HEIs. Another conclusion presents incentives as significantly associated with most UBC activities, except lifelong learning and student mobility, in which no specific incentives seems to be needed or expected by academics.

Offices, such as TTOs or incubators, are important for the development of some UBC activities, but without offices, other activities (i.e. joint curriculum design and delivery and professional mobility) still take place. The importance of the offices is not be reliant on the structures/buildings themselves but on the right skills and behaviours of the people within those offices. Clark (1998) takes a broader view when he talks about the “extended developmental periphery”.

Finally, communication of UBC is not a measure that explicitly define the extent of UBC but relays the appreciation of the UBC value (Korff et al. 2014), therefore it might be a required mechanism to increase UBC awareness in activities that do not depend on markets, like professional mobility, in which communication might contribute to increase the awareness for it.

Results show that those HEIs successfully engaged with industry put in place a series of mechanisms simultaneously at strategic and operational levels, showing that transforming a HEI to be more entrepreneurial requires changes, not only in organizational infrastructure but also others, such as the adaptation of the HEI’s culture and mission (Jacob et al. 2003). However, different UBC activities are affected by different mechanisms, which emphasises the idea that generally, UBC supporting mechanisms need to be aligned with specific UBC activities (Henrekson and Rosenberg 2001).

The European Commission (EC) has attempted to address the ‘modernisation’ of European HEIs through a number of policy instruments, encouraging and pressuring HEIs in equal measures (Mowery and Sampat 2006) to make a greater contribution to economic development. However, generally, the EC policy supporting UBC does not directly regulate organizational mechanisms because these are often regulated at national level. However, it aims to influence and support them through studies (‘The State of European University-Business Cooperation’ or ‘Measuring the Impact of University-Business Cooperation’), events (‘University-Business Forum’ series), guidelines (‘The EC/OECD Guiding Framework for Entrepreneurial Universities’), tools (‘HEInnovate’), communications (‘Communication supporting growth and jobs—an agenda for the modernisation of Europe’s higher education systems’) and projects (‘the Knowledge Alliances’), among others.

## 6.1 Implications

This study generally contributes to the organisational sciences and HEI management research fields by presenting how a series of organisational supporting mechanisms are related with the development different organisational activities within HEIs. Specifically, it contributes to the knowledge transfer in HEIs and UBC research field by increasing the understanding of the role of HEIs organisational support for UBC success, showing a novel combination of seven activities and four groups of supporting mechanisms.

This paper shows a comprehensive picture of the reality, revealing novel relationships not previously identified in literature. Additionally, by pointing out those organisational

mechanisms with the highest impact on the development of UBC activities (i.e. top management support), represents an indication to where future research should focus. This is especially relevant considering the lack of research on the actual management of UBC or on how HEIs' are successfully nurturing UBC over their nature of education and research organisations.

Additionally, this research has implications for the UBC practice, highlighting the importance of the role of policy makers and HEI managers in the UBC success. In line with the concept of evidence-based policy, policy makers should realize that UBC might not naturally happen, but they have the power to stimulate (e.g. through communication) and actively support (e.g. through incentives).

The fact that factors have different effects in each UBC activity, indicate managers and policymakers the suitability of taking a "big picture" approach to UBC considering then seven UBC activities. Therefore, paper calls for a coordination of all HEI units that relate with business in any way (careers office, TTO, innovation office, etc.) within a coordinated common institutional strategy for UBC, in order to create synergies and reach a competitive advantage.

The UBC supporting mechanisms should also be coordinated with the HEI mechanisms that support research and teaching, which can often be contradictory. Since HEIs have added missions and activities without removing the traditional ones, it is essential to properly manage the coexistence of these missions and the integration of UBC in all of them.

Finally, this paper points out which are the mechanisms with a highest impact in UBC activities, indicating managers and policymakers where they should focus their attention, effort, time, money and internal regulations to prioritise their nurturing. A diagnostic of the specific characteristics and mechanisms of their own HEI is needed, and in line with the practice of evidence-based management, a comprehensive UBC strategy should be designed to best adapt to the specific features of the HEI and the academics that are part of it.

## 6.2 Limitations and further research

This study also acknowledges its limitations. As any online distributed questionnaire, the self-selection of the respondents in the sample can provide biased results. Additionally, there can be also potential biases in the questionnaires' translations (despite being translated by professional translators) and in the self-assessment framework for their own perception of development. Further, in this study only relations and no causal effect are reported, meaning the direction of the causality between UBC development and the application of the mechanisms cannot be determined. Finally, there is also an impact limitation concerning the fact that the study was carried out in 33 different countries. Even when this limitation is mitigated controlling for the variable "region", and these organisational mechanisms might not be equally successful across the diverse environments.

There are plenty of possibilities for future research, including a deeper explanation of which incentives systems work better and how or which extended developmental periphery fits what HEI best, for what reasons and to what extent. The respondents in this study were managers and comparing the data from managers with academics could provide insights into the working of the mechanisms from different levels in the organization. As part of the variance in the different UBC activities is still not explained, other significant variables should be identified and added to the equations to increase the amount of explained variance, the age of the HEI or its public/private nature are candidates for such variables,

as well as controlling for whether HEIs count with engineering, life sciences or medical schools. Additionally, future research could explore how European policy supporting UBC influence UBC organisational mechanisms. Finally, the success of these UBC organisational mechanisms can be evaluated at a country level and compared.

Additionally, a study could compare the success of UBC with the mechanisms that all three actors of the Triple Helix have in place to identify to what extent other mechanisms also affect successful UBC or the extent to which business motivations affect HEIs organisational mechanisms. Finally, the same study could be repeated in Europe after a period of time to evaluate the evolution of these perceptions with longitudinal data. Similarly, the study can be carried out outside Europe in order to compare the managers' perceptions in other contexts with the European ones.

**Acknowledgments** The survey design and data collection for this study was funded by the European Commission DG Education and Culture, Public Tender (EAC/37/2009), but has not been involved in the data analysis or the paper writing.

#### **Compliance with ethical standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

## **Appendix: Results of the factor analysis of the UBC supporting mechanisms**

### **Top management support (Cronbach $\alpha = .91$ )**

- A top-level management committed to UBC.
- The presence of academics on company boards.
- The presence of business people on the HEI board.
- Board member or vice rector positions for UBC.

### **Communication (Cronbach $\alpha = .87$ )**

- A documented mission/vision embracing UBC.
- The internal promotion of UBC.
- The external promotion of UBC.

### **Incentives (Cronbach $\alpha = .85$ )**

- The dedication of resources (inc. funding). to support UBC.
- The provision of incentives for academics to encourage UBC.
- The inclusion of UBC as part of the assessment of work performance for academics.

### **Structures/offices (Cronbach $\alpha = .79$ )**

- Career offices within the HEI.
- Internal agencies within the HEI dedicated to UBC.
- Incubators for the development of new business.

## References

- Aldridge, T. T., & Audretsch, D. (2011). The Bayh–Dole act and scientist entrepreneurship. *Research Policy*, *40*(8), 1058–1067.
- Ambos, T. C., Mäkelä, K., Birkinshaw, J., & D’Este, P. (2008). When does university research get commercialised? Creating Ambidexterity in Research Institutions. *Journal of Management Studies*, *45*(8), 1424–1447.
- Arvanitis, S., Kubli, U., & Woerter, M. (2008). University–industry knowledge and technology transfer in Switzerland: What university scientists think about co-operation with private enterprises. *Research Policy*, *37*(10), 1865–1883.
- Bekkers, R., & Freitas, I. M. B. (2008). Analysing knowledge transfer channels between Universities and industry: To what degree do sectors also matter? *Research Policy*, *37*(10), 1837–1853.
- Bozeman, B., Fay, D., & Slade, C. P. (2013). Research collaboration in universities and academic entrepreneurship: The state-of-the-art. *The Journal of Technology Transfer*, *38*(1), 1–67.
- Busch, L., & Lacy, W. B. (1983). *Science, agriculture, and the politics of research*. Boulder, CO: Westview Press.
- Caniëls, M., & van den Bosch, H. (2011). The role of higher education institutions in building regional innovation systems. *Papers in Regional Science*, *90*(2), 271–286.
- Carayol, N. (2003). Objectives, agreements and matching in science–industry collaborations: Reassembling the pieces of the puzzle. *Research Policy*, *32*(6), 887–908.
- Clark, B. (1995). *Places of inquiry: Research and advanced education in modern universities*. Berkeley and Los Angeles: University of California Press.
- Clark, B. (1998). *Creating entrepreneurial Universities: Organizational pathways of transformation*. New York, NY: Pergamon Press.
- Clarysse, B., Tartari, V., & Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Research Policy*, *40*(8), 1084–1093.
- D’Este, P., & Patel, P. (2007). University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy*, *36*(9), 1295–1313.
- D’Este, P., & Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. *The Journal of Technology Transfer*, *36*(3), 316–339.
- Davey, T., Baaken, T., Galán-Muros, V., & Meerman, A. (2011). *Study on the cooperation between Higher Education Institutions and Public and Private Organisations in Europe*. Brussels: European Commission, DG Education and Culture.
- Debackere, K., & Veugelers, R. (2005). The role of academic technology transfer organizational in improving industry science links. *Research Policy*, *34*(3), 321–342.
- Dottore, A., Baaken, T., & Corkingdale, D. (2010). A partnering business model for technology transfer: The case of the Muenster University of Applied Sciences. *International Journal of Entrepreneurship and Innovation Management*, *12*(2), 190–216.
- Enders, J. (2004). Higher education, internationalisation, and the nation-state: Recent developments and challenges to governance theory. *Higher Education*, *47*(3), 361–382.
- Etzkowitz, H. (2001). The second academic revolution and the rise of entrepreneurial science. *IEEE Technology and Society Magazine*, *20*(2), 18–29.
- Etzkowitz, H., & Leydesdorff, L. (1997). Introduction: Universities in the global knowledge economy. In H. Etzkowitz & L. Leydesdorff (Eds.), *Universities and the global knowledge economy: A triple helix of university–industry–government relations* (pp. 1–8). London and Washington: Pinter.
- Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From national systems and “mode 2” to a triple helix of university–industry–government relations. *Research Policy*, *29*(2), 109–123.
- Feller, I., & Feldman, M. (2010). The commercialization of academic patents: Black boxes, pipelines, and Rubik’s cubes. *The Journal of Technology Transfer*, *35*(6), 597–616.
- Fini, R., Grimaldi, R., Santoni, S., & Sobrero, M. (2011). Complements or substitutes? The role of Universities and local context in supporting the creation of academic spin-offs. *Research Policy*, *40*(8), 1113–1127.
- Frey, B., & Neckermann, S. (2008). *Academics appreciate awards—A new aspect of incentives in research*. CESIFO Working Paper Series, 2531.
- Friedman, J., & Silberman, J. (2003). University technology transfer: Do incentives, management, and location matter? *Journal of Technology Transfer*, *28*(1), 17–30.
- Geissler, M., Jahn, S., & Haefner, P. (2006). The entrepreneurial climate at universities: The impact of organisational factors. In D. Smallbone, J. Leitao, M. Raposo, & F. Welter (Eds.), *The theory and practice of entrepreneurship—Frontiers in European entrepreneurship research*. Cheltenham, MA: Edward Elgar.

- Geuna, A., & Nesta, L. J. (2006). University patenting and its effects on academic research: The emerging European evidence. *Research Policy*, 35(6), 790–807.
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, S., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research contemporary societies*. London: Sage.
- Goddard, J. B., & Chatterton, P. (1999). Regional development agencies and the knowledge economy: Harnessing the potential of universities. *EPC Government and Policy*, 17, 685–699.
- Göktepe-Hulten, D., & Mahagaonkar, P. (2009). Inventing and patenting activities of scientists: In the expectation of money or reputation? *Journal of Technology Transfer*, 35(4), 401–423.
- Grimaldi, R., Kenney, M., Siegel, D. S., & Wright, M. (2011). 30 Years after Bayh–Dole: Assessing academic entrepreneurship. *Research Policy*, 40(8), 1045–1057.
- Grimpe, C., & Fier, H. (2010). Informal university technology transfer: A comparison between the United States and Germany. *Journal of Technology Transfer*, 35(6), 637–650.
- Guerrero, M., Cunningham, J. A., & Urbano, D. (2015). Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom. *Research Policy*, 44(3), 748–764.
- Gulbrandsen, M., & Slipersaeter, S. (2007). The third mission and the entrepreneurial university model. In A. Bonaccorsi & C. Daraio (Eds.), *Universities and strategic knowledge creation—Specialization and performance in Europe* (pp. 112–143). Cheltenham, MA: Edward Elgar.
- Harryson, S. J. (2008). Entrepreneurship through relationships—Navigating from creativity to commercialization. *R&D Management*, 38(3), 290–310.
- Henrekson, M., & Rosenberg, N. (2001). Designing efficient institutions for science-based entrepreneurship: Lesson from the US and Sweden. *Journal of Technology Transfer*, 26(3), 207–231.
- Hughes, A. (2006). *University–industry linkages and UK science and innovation policy*. ESRC Centre for Business Research, University of Cambridge. CBR Research Programme on Enterprise and Innovation, Working Paper 326.
- Jacob, M., Lundqvist, M., & Hellsmark, H. (2003). Entrepreneurial transformations in the Swedish university system: the case of Chalmers university of Technology. *Research Policy*, 32(9), 1555–1568.
- Jain, S., George, G., & Maltarich, M. (2009). Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Research Policy*, 38(6), 922–935.
- Johnson, W. H. (2009). Intermediates in triple helix collaboration: The roles of 4th pillar organisations in public to private technology transfer. *International Journal of Technology Transfer and Commercialisation*, 8(2–3), 142–158.
- Katz, J. S. (2000). Scale-independent indicators and research evaluation. *Science and Public Policy*, 27(1), 23–36.
- Kaufmann, A., & Tödting, F. (2001). Science–industry interaction in the process of innovation: the importance of boundary-crossing between systems. *Research Policy*, 30(5), 791–804.
- Kitagawa, F., & Lightowler, C. (2013). Knowledge exchange: A comparison of policies, strategies, and funding incentives in English and Scottish higher education. *Research Evaluation*, 22(1), 1–14.
- Klofsten, M., & Jones-Evans, D. (2000). Comparing academic entrepreneurship in Europe—The case of Sweden and Ireland. *Small Business Economics*, 14(4), 299–309.
- Korff, N., Van der Sijde, P., Groenewegen, P., & Davey, T. (2014). Supporting university–industry linkages—A case study of the relationship between the organisational and individual levels. *Industry and Higher Education*, 28(4), 281–300.
- Kruss, G., Aphane, M., Muller, L., & Manamela, A. (2011). *Promoting higher education–industry partnerships and collaborations*. South Africa: Research and Innovation Strategy Group, Higher Education.
- Lach, S., & Schankerman, M. (2003). Incentives and invention in Universities. 9727. *National Bureau of Economic Research*, Cambridge, MA.
- Lam, A. (2011). What motivates academic scientists to engage in research commercialization: “Gold”, “ribbon” or “puzzle”? *Research Policy*, 40(10), 1354–1368.
- Lamichhane, S., & Sharma, T. N. (2013). University–industry relations: A thrust for transformation of knowledge and economic acceleration. *Journal of Education and Research*, 2, 59–66.
- Link, A., & Siegel, D. (2005). Generating science-based growth: An econometric analysis of the impact of organizational incentives on university–industry technology transfer. *The European Journal of Finance*, 11(3), 169–181.
- Lockett, A., Siegel, D., Wright, M., & Ensley, M. D. (2005). The creation of spin-off firms at public research institutions: Managerial and policy implications. *Research Policy*, 34(7), 981–993.
- Loi, M., & Di Guardo, M. C. (2015). The third mission of universities: An investigation of the espoused values. *Science and Public Policy*, doi:10.1093/scipol/scv012.

- Lubango, L. M., & Pouris, A. (2007). Industry work experience and inventive capacity of South African academic researchers. *Technovation*, 27(12), 788–796.
- Markman, G. D., Gianiodis, P. T., Phan, P. H., & Balkin, D. B. (2004). Entrepreneurship from the ivory tower: Do incentive systems matter?—Universities role in regional innovation system. *Journal of Technology Transfer*, 29(3–4), 353–364.
- Mathieu, M. (2003). An integrated approach to academic reinforcement systems. *Higher Education Management and Policy*, 15(3), 25–40.
- Meyer-Krahmer, F., & Schmoch, U. (1998). Science-based technologies: university–industry interactions in four fields. *Research Policy*, 27(8), 835–851.
- Mitton, C., Adair, C. E., McKenzie, E., Patten, S. B., & Wayne Perry, B. (2007). Knowledge transfer and exchange: Review and synthesis of the literature. *The Milbank Quarterly*, 85(4), 729–768.
- Mowery, D. C., & Sampat, B. N. (2006). Universities in national innovation systems. In J. Fagerberg, D. C. Mowery, & R. R. Nelson (Eds.), *Oxford handbook of innovation*. Oxford, UK: Oxford University Press.
- Muscio, A., & Pozzali, A. (2012). The effects of cognitive distance in university–industry collaborations: Some evidence from Italian universities. *The Journal of Technology Transfer*, 37(3), 1–23.
- Nilsson, A. S., Rickne, A., & Bengtsson, L. (2010). Transfer of academic research: Uncovering the grey zone. *The Journal of Technology Transfer*, 35(6), 617–636.
- OECD (2002). Benchmarking science–industry relationships, Paris. <http://www.oecd-ilibrary.org/>. Accessed 3 February, 2015.
- Pajunen, K. (2008). The nature of organizational mechanisms. *Organization Studies*, 29(11), 1449–1468.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D’Este, P., et al. (2013). Academic engagement and R&D commercialisation: A review of the literature on university–industry relations. *Research Policy*, 42(2), 423–442.
- Phan, P. H., & Siegel, D. S. (2006). The effectiveness of university technology transfer: Lessons learned from quantitative and qualitative research in the US and the UK. *Foundations and Trends in Entrepreneurship*, 2(2), 1–53.
- Plewa, C., Korff, N., Johnson, C., MacPherson, G., Baaken, T., & Rampersad, G. (2013). The evolution of university–industry linkages—A framework. *Journal of Engineering and Technology Management*, 30(1), 21–44.
- Plewa, C., Qvester, P., & Baaken, T. (2006). Organisational culture differences and market orientation: an exploratory study of barriers to university–industry relationships. *International Journal of Technology Transfer and Commercialisation*, 5(6), 373–389.
- Polz, W., Rammer, C., Gassler, H., Schibany, A., & Schartinger, D. (2001). Benchmarking industry–science relations: The role of framework conditions. *Science and Public Policy*, 28(4), 247–258.
- Ponomariov, B. L. (2008). Effects of university characteristics on scientists’ interactions with the private sector: An exploratory assessment. *Journal of Technology Transfer*, 33(5), 485–503.
- Rasmussen, E., Moen, Ø., & Gulbrandsen, M. (2006). Initiatives to promote commercialization of university knowledge. *Technovation*, 26(4), 518–533.
- Renault, C. S. (2006). Academic capitalism and university incentives for faculty entrepreneurship. *Journal of Technology Transfer*, 31(2), 227–239.
- Roges, E. M. (2002). The nature of technology transfer. *Science Communication*, 23(3), 323–341.
- Rossi, F., & Rosli, A. (2013). Indicators of university–industry knowledge transfer performance and university implications for Universities: evidence from the UK’s HE-BCI survey. Working Paper. Birkbeck College, London: university of London.
- Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: A taxonomy of the literature. *Industrial and Corporate Change*, 16(4), 691–791.
- Rothaermel, F. T., & Thursby, M. (2005). University–incubator firm knowledge flows: Assessing university impact on incubator firm performance. *Research Policy*, 34(3), 305–320.
- Santoro, M. D., & Chakrabarti, A. K. (2002). Firm size and technology centrality in industry–university interactions. *Research Policy*, 31(7), 1163–1180.
- Santoro, M. D., & Gopalakrishnan, S. (2000). The institutionalization of knowledge transfer activities within industry–university collaborative ventures. *Journal of Engineering and Technology Management*, 17(3), 299–319.
- Servos, J. W. (1980). The industrial relations of science chemical engineering at MIT, 1900–1939. *Isis*, 71(4), 531–549.
- Shane, S. A. (2004). *Academic entrepreneurship: University spinoffs and wealth creation*. Cheltenham, MA: Edward Elgar.

- Siegel, D. S., & Phan, P. H. (2005). Analyzing the effectiveness of university technology transfer: Implications for entrepreneurship education. *Advances in the Study of Entrepreneurship, Innovation and Economic Growth*, 16, 1–38.
- Siegel, D. S., Veugelers, R., & Wright, M. (2007a). Technology transfer offices and commercialization of university intellectual property: Performance and policy implications. *Oxford Review of Economic Policy*, 23(4), 640–660.
- Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2003a). Commercial knowledge transfers from Universities to firms: Improving the effectiveness of university industry collaboration. *Journal of High Technology Management Research*, 14(1), 111–133.
- Siegel, D. S., Waldman, D. A., Atwater, L. E., & Link, A. N. (2004). Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: Qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management*, 21(1), 115–142.
- Siegel, D. S., Waldman, D., & Link, A. (2003b). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Research Policy*, 32(1), 27–48.
- Siegel, D. S., Wright, M., & Lockett, A. (2007b). The rise of entrepreneurial activity at Universities: Organizational and societal implications. *Industrial and Corporate Change*, 16(4), 489–504.
- Slaughter, S., & Rhoades, G. (1996). The emergence of a competitiveness research and development policy coalition and the commercialization of academic science and technology. *Science, Technology and Human Values*, 21(3), 303–339.
- Sporn, B. (2001). Building adaptive universities: Emerging organisational forms based on experiences of European and US Universities. *Tertiary Education and Management*, 7(2), 121–134.
- Ssebuwufu, J., Ludwick, T., & Béland, M. (2012). *Strengthening university–industry linkages in Africa—A study on institutional capacities and gaps*. Accra: Association of African Universities–Association of Universities and Colleges of Canada.
- Stephan, P. E. (2008). Science and the university: Challenges for future research. *CESifo Economic Studies*, 54(2), 313–324.
- Stinchcombe, A. L. (1965). Social structure and organisation. In J. G. March (Ed.), *Handbook of organizations* (pp. 142–193). London: Routledge.
- Stinchcombe, A. L. (1968). *Constructing social theories*. New York, NY: Harcourt, Brace and World.
- Tartari, V., & Breschi, S. (2011). Set them free: Scientists’ evaluations of the benefits and costs of university–industry research collaboration. *Industrial and Corporate Change*, 21(5), 1117–1147.
- Teichler, U. (2008). Diversification? Trends and explanations of the shape and size of higher education. *Higher Education*, 56(3), 349–379.
- Teixeira, A., & Mota, L. (2012). A bibliometric portrait of the evolution, scientific roots and influence of the literature on university–industry links. *Scientometrics*, 93(3), 719–743.
- Thompson, G. N., Estabrooks, C. A., & Degner, L. F. (2006). Clarifying the concepts in knowledge transfer: A literature review. *Journal of Advanced Nursing*, 53(6), 691–701.
- Thursby, J. G. A., Jensen, R. A., & Thursby, M. C. A. (2001). Objectives, characteristics and outcomes of university licensing: A survey of major US Universities. *Journal of Technology Transfer*, 26(1), 59–72.
- Tornatsky, L. G., Waugaman, P. G., & O’Gray, D. (2002). *Innovation U: New university roles in a knowledge economy*. Research Triangle Park, NC: Southern Technology Council.
- Van der Sijde, P. (2012). Profiting from knowledge circulation: The gains from university–industry interaction. *Industry and Higher Education*, 26(1), 15–19.
- Van Geenhuizen, M. (2010). *Valorisation of knowledge: Preliminary results on valorisation paths and obstacles in bringing university knowledge to market*. In: Proceedings of the eighteenth annual high technology small firms conference, university of Twente, Enschede, The Netherlands.
- Van Rijnsoever, F. J., & Hessels, L. K. (2011). Factors associated with disciplinary and interdisciplinary research collaboration. *Research Policy*, 40(3), 463–472.
- Vroom, V. H. (1964). *Work and Motivation*. New York: Wiley.
- Wilson, T. (2012). A review of business–university collaboration. London: Department for Business Innovation and Skills. UK Government [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/32383/12-610-wilson-review-business-university-collaboration.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32383/12-610-wilson-review-business-university-collaboration.pdf). Accessed 25 November, 2014.
- Wissemá, J. G. (2009). *Towards the third generation university, managing the university in transition*. Cheltenham, MA: Edward Elgar.
- Yencken, J., & Ralston, L. (2005). *Evaluation of incentives for R&D commercialisation of research in Australian Universities: A survey of selected Australian Universities*. Australia: Department of Education, Science and Training.