Chapter 10
Academic Interactions with Private, Public and Not-for-Profit Organisations: The Known Unknowns

Maria Abreu and Vadim Grinevich

1 Introduction

An increased emphasis on the role of innovation in economic development has focused attention on the university as an important contributor to the innovation process. Universities are engaged in research and education and, therefore, provide critical resources for innovation such as skills and knowledge. They are one of the main organisational elements of the innovation system (Cooke et al. 1997; Lundvall 1992; Nelson 1993) and one which is involved, through market and non-market linkages, with other innovation agents including business, government and non-governmental organisations.

While there is a growing recognition that the engagement of the university with the economy extends well beyond the private sector (Etzkowitz et al. 2000; Etzkowitz 2003; Belkhodja and Landry 2007), most of the current literature tends to focus on knowledge transfer processes, which involve the private industry only. To no small degree, this is due an ongoing emphasis, in both the academic and policy discourse, on market-based activities, such as licensing of patented academic inventions, spin-off formation and other commercialisation activities (Baldini et al. 2007; Christman et al. 1995; Kenney and Goe 2004; Klofsten and Jones-Evans 2000). These are most relevant for private profit-driven firms, with not-for-profit and public sector organisations being rarely considered to be an appropriate partner in such context.

In this chapter, we explicitly aim to bring the public and third (not-for-profit) sectors into focus of the debate on the university engagement with the economy. These sectors of the economy are important providers of public goods and social welfare. The university is closely interlinked with both of them and the private sector.

M. Abreu (✉)
Pembroke College, University of Cambridge, Cambridge CB2 1RF, UK
e-mail: ma405@cam.ac.uk

V. Grinevich
Department of Architecture, University of Cambridge, Cambridge, UK

J.J.M. Ferreira et al. (eds.), *Cooperation, Clusters, and Knowledge Transfer*,
Advances in Spatial Science, DOI 10.1007/978-3-642-33194-7_10,

It, therefore, has an important role to play not only in business innovation but also in public and social innovation. The latter is often overlooked by the university technology transfer offices (TTOs), which are primarily charged with the task of commercialisation of the university research. Although the performance of TTOs is now judged by a few community engagement indicators (HE-BCI 2007), the TTO support mechanisms rarely extend beyond for-profit activities oriented towards the private sector. As we identify the extent and factors of academic interactions with the private, public and third sectors, we provide a balanced picture on the socio-economic role of the university and further inform university policies on a range of instruments that can be deployed to enhance that role.

Our unit of analysis is an individual academic who is engaged, via both formal and informal channels, not only with private firms but also with public and third sector organisations. We cover all academic disciplines and all academic and research positions within the higher education system of the United Kingdom. We also introduce a spatial dimension to investigate the role of academic location on different types of interactions.

The rest of the chapter is organised as follows. Section 2 provides an overview of the key concepts of the university engagement with the economy. Section 3 examines in detail the main determinants of academic engagement with industry and other non-academic partners and presents a number of hypotheses. Section 4 describes the data and methodology used in the paper, followed by a discussion of the empirical results in Sect. 5. Section 6 discusses the key findings and concludes.

2 Understanding the Interface Between the University and the Economy

Since at least the 1940s when Vannevar Bush, then director of the US Office of Scientific Research and Development, published his strategic view on the relationship between science and industry (Bush 1945), the conceptualisation of the role of universities in the economy has been firmly positioned within the innovation policy debate. However, the linear model of innovation advocated in Bush (1945) is no longer popular with policymakers and academics. It has been heavily criticised for presenting a simplistic one-way relationship between academic science and innovations developed by applied industrial research (Cohen et al. 2002; Jacobsson 2002; Kline and Rosenberg 1986).

The development of innovation systems approach in 1980s and 1990s led to a richer and more sophisticated conceptualisation of university–industry relationships, involving multiple feedback loops between science and industry (Freeman 1987; Lundvall 1992; Nelson 1993). There are a number of definitions of the innovation system, but the literature generally defines it as the actors and institutions that affect the creation, development and diffusion of innovations (Mowery and Sampat 2005). As one of these actors, the university is actively involved via formal and informal

channels in iterative and interactive relationships with other innovation system players. The links between the university and other organisations can take the form of flows of knowledge, information, investment funding, policy as well as more informal arrangements such as networks, clubs, forums and partnerships (Cooke et al. 1997).

An interactive characterisation of the innovation process resonates well with the concept of the university as an institution that combines activities related to both considerations of use and the pursuit of fundamental understanding (Stokes 1997). In practice, the distinction between these two dimensions of university activity is rather blurred, with the paths between scientific discovery and industry innovation involving multiple feedback loops and interactions. These can be realised through a variety of channels such as educating students and workers, increasing the stock of codified knowledge, technological problem-solving, spin-out formation and different public space functions (Lester 2003).This view is strongly supported by the extensive literature on the extent and variety of university–industry interactions, which can be approached from the point of view or business or academia (Agrawal and Henderson 2002; Arundel and Geuna 2004; Cohen et al. 2002; D'Este and Patel 2007; Faulkner and Senker 1994; Schartinger et al. 2001).

The increasing engagement of the university with industry and other non-academic partners is often referred to as the "entrepreneurial university phenomenon" (Etzkowitz et al. 2000; Etzkowitz 2003). It is interpreted as a natural development of the university mission to address the needs of a modern, knowledge-based economy. In a major survey, Rothaermel et al. (2007) identify several broad streams of existing research on the concept of university entrepreneurship. These relate to university policy and incentive systems in place to promote technology transfer (Friedman and Silberman 2003; Powers and McDougall 2005);university status and identity; cultural, historic and geographical context (Etzkowitz 2003; Jacob et al. 2003; Mansfield 1995; Thursby et al. 2001); the role of intermediaries such as TTOs and incubators (Collins and Wakoh 2000; Del Campo et al. 1999; Markman et al. 2004); government policies, industry conditions and the technologies involved (Agrawal and Henderson 2002; Gulbrandsen and Smeby 2005; Harmon et al. 1997; Mowery et al. 2001); and, finally, the characteristics and roles of the faculty members (Christman et al. 1995; Louis et al. 2001). Essentially, the notion of the entrepreneurial university incorporates three key components, the individual entrepreneur, the immediate institutional environment and external factors.

Most recently, several studies including Azagra-Caro et al. (2006), D'Este and Patel (2007) and Gulbrandsen and Smeby (2005) have demonstrated that focusing on individual academics and contextual factors, the latter of which define the way in which academics interact with industry, represents a very efficient analytical framework to analyse the relatively fragmented literature on university–industry interactions. In the UK context, studies by D'Este and Patel (2007) and D'Este and Perkmann (2010) find that the personal characteristics of individual academics have greater impact on explaining the interactions than institutional characteristics. Another interesting finding is that most academics engage with industry to advance their research rather than to commercialise it.

While providing important insights into the nature and motivations behind academic interactions with industry, one clear limitation of the existing literature is that it mainly focuses on academic interactions related to profit-generating activities, leaving out public and third sector interactions (Baldini et al. 2007; Christman et al. 1995; Kenney and Goe 2004; Klofsten and Jones-Evans 2000; Shane 2004; Roberts 1991). This is despite the fact that both the innovation systems and academic entrepreneurship literature have argued for some time that government and nongovernment organisations along with the university and private firms are all intrinsically intertwined in the process of generating economic value from innovation (Mowery and Sampat 2005; Etzkowitz et al. 2000; Etzkowitz 2003). Also, from the innovation policy perspective, the university is increasingly encouraged to enhance its capability to address the needs of both business and the wider community. Still most of the efforts of the university and TTOs focus on translating academic research into the marketplace only.

We aim to overcome this narrow interpretation of the interface between the university and the economy by analysing interactions of academics with the private, public and third sectors. In each case, we imply that individual academics are engaged with non-academic partners via variety of formal and informal channels such as licensing, spin-outs, consulting, contract research, testing, meetings, conferences and joint publications. We cover all academic disciplines, all academic and research positions and the entire range of the higher education sector in the UK. By doing so, we aim to provide a balanced picture on the engagement of the university with all key sectors of the economy and contribute to the policy debate on the development of so called "third stream" (i.e. beyond teaching and research) activities of the university.

As discussed above, the literature on academic entrepreneurship has analysed the determinants of academic interactions as a combination of individual characteristics of academics, the immediate institutional environment and locational factors. In this chapter we deploy a similar framework. We next describe the existing research findings in relation to the commercialisation of academic research and the implications for academic interactions with the public and third sectors.

3 Determinants of Academic Entrepreneurship

Most studies of academic entrepreneurship have focused on the university as the unit of analysis, often using interviews with university officials and academics, or surveys of departments in a particular academic field (Murray and Graham 2007; Owen-Smith and Powell 2001; Seashore Louis et al. 1989; Siegel et al. 2003). This has gradually changed since the 1990s with the arrival of large quantitative data sources, such as the Survey of the Association of University Technology Managers (AUTM) in the United States (Rothaermel et al. 2007). The use of large surveys and new individual-level data sets has allowed the quantitative study of both individual traits and institutional factors.

When it comes to the definition of academic entrepreneurship, most studies adopt a narrow concept associated with patenting, licensing or spin-out activities only (Baldini et al. 2007; Christman et al. 1995; Kenney and Goe 2004). Others suggest a broader definition which covers any commercialisation activities outside teaching and personal research (Klofsten and Jones-Evans 2000) and may include less formal interactions such as meetings, conferences (D'Este and Patel 2007; Landry et al. 2005) and joint publications (Link et al. 2007). Most studies centre on a particular set of academic disciplines, such as science, engineering and medicine. A few studies do cover both the sciences and humanities, but may be selective in relation to other aspects of analysis such as the variety of interactions, the type and location of academic institutions, and the employment characteristics of its subjects (Campbell and Slaughter 1999; Azagra-Caro et al. 2006; Christman, et al. 1995; Gulbrandsen and Smeby 2005).

As we discuss the findings of the literature on individual, institutional and spatial characteristics of academic entrepreneurship, we note the unresolved issues with respect to the engagement of academics with the public and third sectors. We imply that interacting academics seek to generate some value for their research outside academia and capitalise on it either commercially or professionally, for instance, in terms of teaching content, further research and reputation.

3.1 Individual Characteristics

3.1.1 Life Cycle

Life cycle models of academic careers indicate that the academic engagement in commercialisation activities increases with age. Early career researchers are more concerned with publishing their work rather than commercialising it as they seek to establish their reputation in the field, while older, more experienced academics, with an established reputation, have more opportunities to cash in on their research (Carayol 2007; Levin and Stephan 1991; Stephan et al. 2007). However, a counter-argument can also be made, whereby commercial and other entrepreneurial activities have become more prevalent in academia over time, so that the time spent on these activities is greater among younger cohorts who are more familiar with the procedures involved and who look more favourably on them (Azoulay et al. 2007). The empirical evidence is mixed, with different studies identifying positive (Azoulay et al. 2007; Morgan et al. 2001; Stephan et al. 2007), negative (Ambos et al. 2008) or insignificant (Link et al. 2007) effects of age on commercialisation of research, while others identify an inverted U-shaped relationship (Levin and Stephan 1991; Thursby and Thursby 2005). In studies that account for both age and career status, age has been found to have negative effect on commercialisation, while status has a positive or insignificant effect (Bercovitz and Feldman 2003; D'Este and Perkmann 2010). Although commercialisation activities have now become a more widespread among younger academics, this is not necessarily the case for their interactions with the

public and third sectors, where experience, reputation and status can still be very relevant. We explore these issues in detail by studying the effect of age and career status on the probability to engage with profit-generating firms, public sector institutions and non-for-profit organisations.

3.1.2 Gender

A few studies have investigated the role of gender in academic entrepreneurship. The results suggest that female scientists are less likely to commercialise their work (Ding et al. 2006; Thursby and Thursby 2005; Whittington and Smith-Doerr 2005). A number of explanations have been provided, although none has been found to explain the entire effect. The risky nature of some commercialisation activities may deter female academics who may be more risk averse than their male counterparts (Stephan and El-Ganainy 2007). A number of studies have found that female academics are less likely to have commercial sector experience and contacts in industry-related networks, which can also limit the potential for commercialisation (Ding et al. 2006; Murray and Graham 2007). Female academics may also be less likely to work in fields that are conducive to commercialisation and may be deterred by venture capitalists who tend to operate in a male-dominated environment (Stephan and El-Ganainy 2007). It is also found that female academics are more ambivalent about the ethics and benefits of research commercialisation than their male counterparts (Murray and Graham 2007).

We analyse the role of gender in relation to academic interactions which go beyond commercialisation activities, to see whether the gender gap still persists there. We expect, however, some of the critical issues, such as risk aversion and the ethics of commercialisation, to be less relevant in the context of interactions with the public and third sectors. We also control for previous commercial, public sector and third sector experience and type of research when assessing the persistence of the gender gap.

3.1.3 Academic Discipline and Type of Research

The incidence of academic entrepreneurship is closely linked to the field of study. For instance, Murray (2002) describes how fundamental research and applied work in biomedicine tend to co-evolve, with many applications flowing directly from existing lines of research. In other fields such as theoretical physics, however, substantial additional work may be needed before an application can be commercialised. The type of intellectual property arising from research also varies across disciplines. For instance, in computer science, the creative arts, humanities and the social sciences copyright and trademarks are more common than patents. Stephan et al. (2007) argue that research in fields with high patent counts, such as the life sciences, readily lends itself to commercialisation because it is both fundamental and also inspired by considerations of use, in line with the typology developed by Stokes (1997).

We follow the same approach and distinguish between pure basic research, user-inspired basic research and applied research (Stokes 1997, p. 73). We also consider whether academics from disciplines which do not generally engage in formal commercialisation activities, such as the creative arts and humanities, have links with partners in the public and third sectors.

3.1.4 Previous Experience

The literature has identified the importance of prior experience, such as owning a small business or having an immediate family member who owns a small business, in encouraging entrepreneurial behaviour (Klofsten and Jones-Evans 2000). Similarly, Mosey and Wright (2007) show that inexperienced entrepreneurs find it difficult to match their technology to a market need, although some help is available in the form of TTOs, government advisors and proof-of-concept funding. They also struggle to breach the gap between their scientific research networks and industry networks, particularly with respect to equity finance, management and industry partners. Dietz and Bozeman (2005) also find that scientists with a substantial part of their career being spent in industry get more funding from industry and have a higher rate of commercialisation activity. We investigate the role of previous experience by testing whether prior work in the private, public and third sectors affects the likelihood of academic engagement with non-academic partners.

3.1.5 Multiple Roles

Another factor to consider is relationship between the traditional roles of teaching and research, and academic entrepreneurship. There is a substantial literature on the impact of research productivity and quality on commercialisation, which has mostly found that higher research productivity is associated with higher commercialisation activity (Carayol 2007; Stephan et al. 2007; Thursby and Thursby 2003), although Agrawal and Henderson (2002) find that the relationship is neutral, so that the publication and commercialisation are neither complements nor substitutes. This relationship may also be changing over time with the expansion of university-affiliated research centres and provision of grants linked to specific research projects (Dietz and Bozeman 2005). The effect of being employed in a more research-intensive position is ambiguous. On the one hand, having more research time is likely to result in more research that can be commercialised, but, on the other hand, the incentives to publish may be greater as researchers are judged on their academic output, which is necessary to secure a tenure-track position. Using data on researchers at a major French university, Carayol (2007) finds some evidence that full-time researchers commercialise more than those employed on teaching and research contracts.

The evidence with respect to teaching is less clear-cut. There is speculation that a greater focus on commercialisation will shift resources away from education,

but there is as yet little empirical evidence to support this, and possible benefits include access to materials and equipment as well as better student placements (Baldini 2008; Geuna and Nesta 2006; Stephan 2001). While it is unlikely that academics in teaching-only positions will be heavily involved in commercialisation activities, they may still be providing specialised courses and delivering lectures across private, public and not-for-profit organisations. We test the impact of university roles on academic interactions with non-academic partners by considering whether there is a difference between academics involved in teaching only, research only, and those involved in both teaching and research.

3.2 Institutional Characteristics

Institutional factors occur at both the department and university-wide level and include incentives, cultural norms, networks and organisational structures. The literature has mostly focused on the role played by the TTO, which is both in charge of protecting the higher education institution's intellectual property and helping academic staff to commercialise their research. This creates a complex set of incentives, whereby the academic staff members decide whether to disclose their findings to the TTO, and the TTO must decide whether to commercialise them and how, and negotiate with potential users (Jensen and Thursby 2003; Siegel et al. 2007). The role of the TTO is less well understood in relation to the public and third sectors and in the context of the wider diffusion of research in fields such as the arts, humanities and social sciences, where intellectual property is frequently in the form of copyright and is often retained by the original creator. We investigate this issue by considering the incentives faced by academic staff and the organisation of departments and units involved in knowledge transfer at each institution.

3.2.1 Incentive Systems

In a study of 115 TTOs in the USA, Link and Siegel (2005) find that universities that allocate a higher proportion of royalties to the academic inventor have higher rates of commercial output—a conclusion that was also reached by a study of 48 UK universities (Locket and Wright 2005). Non-pecuniary benefits are also important; Link et al. (2007) argue that credits towards promotion and tenure may encourage higher levels of participation and disclosure among academic staff. The literature has highlighted several additional issues, including the fact that many academics do not disclose their inventions to their university and instead rely on informal channels to interact with industry (Siegel et al. 2004; Thursby et al. 2001). This brings benefits such as access to specialised equipment and sponsorship for new projects and tends to occur when the process of commercialising through the TTO is too inflexible and bureaucratic, and incentive structures are not adequate to keep the inventor involved in the commercialisation process (Lee 1996; Siegel et al. 2004). We analyse the

importance of incentives and in particular the weight given to research and commercialisation in the context of career advancement and promotion by the higher education institutions and whether the university board has private, public and third sector participants.

3.2.2 In-House Facilities and Organisational Design

In their study of US TTOs, Link and Siegel (2005) find that academics are generally dissatisfied with the level of bureaucracy and skills of TTO staff. This is supported by qualitative studies, many of which find high levels of frustration with the university bureaucracy (Link et al. 2007; Siegel et al. 2004). Many academics cite problems related to the organisation of knowledge transfer, such as the high rate of turnover of TTO officers, their insufficient marketing and business experience and the need for incentive compensation schemes (Link et al. 2007). The literature has highlighted the importance of having a mix of skills and activities in the TTO, including support for contract research, licensing and spin-out creation and business, legal and negotiating skills (Debackere and Veugelers 2005; Markman et al. 2005). Improving the structure and performance of the TTO may lead to a temporary fall in commercial output; Macho-Stadler et al. (2007) show that TTOs may need to reach a critical size to be successful and may initially shelve some projects in order to build a reputation for delivering good projects. We analyse the importance of organisational structure for different types of the academic engagement with the economy by studying whether their incidence changes if the TTO provides services in-house, sources them from external providers or does not provide facilities for commercialisation.

3.3 Spatial Characteristics

3.3.1 Access to Potential Partners and Networks

The literature on the geography of innovation has identified the importance of personal contacts in developing collaborative relationships, since they facilitate knowledge exchange and the development of new ideas (Anselin et al. 1997; Arundel and Geuna 2004; Cooke 2001, 2002; Feldman 1994; Henderson et al. 1998; Jaffe 1989). University–industry links have also been shown to depend on the quality of the research institution (Mansfield and Lee 1996). Companies will often turn to the highest ranked university department in their field, sometimes searching globally for the ideal academic partner, unless the research is needed urgently or is of an especially confidential nature (Abreu et al. 2008). On the other hand, top quality universities may be more likely to attract interest from local businesses, particularly

for formal types of collaboration (Abramovsky et al. 2007; D'Este and Iammarino 2010; Laursen et al. 2010; Mansfield and Lee 1996). Academics working in remote universities may, despite the advances of modern technology, struggle to maintain contacts in industry and business or find it more difficult to identify potential users of their research. We analyse the importance of geography for academic interactions by considering the effect of population density and distance to London on the likelihood that an individual academic will be engaged with external organisations while controlling for the research intensity of the university and other individual and institutional characteristics.

3.3.2 Regional Government Policy

In the UK, as in most industrialised countries, there is a great deal of government policy interest in encouraging university links with businesses and impact on wider regional socio-economic development. Financial support for academic entrepreneurship (or "third stream funding") comes from a variety of sources. The Higher Education Funding Council for England (HEFCE) supports university outreach activities via its Higher Education Innovation Fund (HEIF), with similar support in Wales, Scotland and Northern Ireland being provided by the devolved administrations. The Department for Business, Innovation and Skills (BIS) promotes knowledge exchange through the Knowledge Transfer Partnerships, a UK-wide programme that allows qualified personnel (typically a recent graduate or university-based researcher) to spend a period of 1–3 years working in a local business, under the supervision of both the business and a university-based scientist. Until very recently, regional development authorities have included university collaboration with businesses and the wider society in their strategic plans, although the extent of support varies by region (and devolved administration). As gatekeepers of much of the European Regional Development Fund (ERDF) and European Social Fund (ESF), the regional authorities have encouraged academic interaction with the local community, particularly with respect to small and medium-sized enterprises (SMEs). While it is difficult to quantify the magnitude of different support programmes at a regional level, we investigate the overall effect of regional policy (and other regional variation) on the academic engagement with private, public and third sector organisations by analysing the variation of academic interactions by region.

4 Data and Methods

4.1 Data Sources

Our analysis is based on a survey of UK academics, conducted over 2008–2009 as part of a wider ESRC-funded research project based at the Centre for Business

Research, University of Cambridge (Abreu et al. 2009).[1] The aim of the project was to capture the wide range of activities that link universities and businesses and analyse the impact of these links on regional economies in the UK. As the project progressed it became apparent that many academic links were with public sector and not-for-profit organisations, and the survey of academics was subsequently designed to include these links in addition to links with business and industry. The data set, its documentation and survey instrument are available through the UK Data Archive.[2]

The sampling frame for the survey of academics included all academics based at UK higher education institutions who at the time of asking were involved in teaching and/or research. Because there is no unified listing of academic staff active in the UK, the sampling frame was constructed using information available on university websites, and the survey was administered through an online web-survey tool. The total number of survey recipients was 126,120, and the achieved sample was 22,556, which also includes a number of paper-based questionnaires, for a response rate of 17.8 %.[3] As far as we are aware, this is the first survey of its kind to cover all disciplines, institutions and job categories within a country's higher education sector. The survey includes questions on interactions with private, public and not-for-profit organisations, individual characteristics, views on the benefits and difficulties of academic entrepreneurship and the geography of academic links with external organisations. The questions in the survey cover the 3 year period prior to the survey (2005–2008).

In addition to the survey, we use institutional data provided by the "Higher Education—Business and Community Interaction Survey 2007–2008", which includes questions on third stream activities, funding and university resources over the period 2007–2008 (HE-BCI 2007).[4] Data on population at the local authority district/unitary authority level, used to construct population density estimates, are based on Office for National Statistics (ONS) population estimates for 2005 (ONS 2005).[5]

[1] The project was sponsored by Economic and Social Research Council (ESRC) in partnership with the Scottish Funding Council (SFC), Department for Employment and Learning (DEL) in Northern Ireland, the Higher Education Funding Council for England (HEFCE) and the Higher Education Funding Council for Wales (HEFCW). Further details on the project are available on the Centre for Business Research website: http://www.cbr.cam.ac.uk/research/programme1/project1-17.htm.

[2] The survey is listed on the UK Data Archive website http://www.data-archive.ac.uk under "Cambridge Centre for Business Research Survey of Knowledge Exchange Activity by United Kingdom Academics, 2005–2009", archive no. SN 6462 (Hughes et al. 2010).

[3] See Abreu et al. (2009) for further details.

[4] The "Higher Education—Business and Community Interaction Survey 2007–08" data are available through the Higher Education Funding Council for England (http://www.hefce.ac.uk/pubs/hefce/2009/09_23).

[5] Available through the Office for National Statistics (www.statistics.gov.uk/popest/).

4.2 Methods

As we consider the effects of individual, institutional and spatial factors on the engagement of academics with the private, public and third sectors, in a first stage of analysis we investigate whether involvement with these different sectors of the economy varies by academic discipline and by UK region.

In a second stage, we run a set of probit regression models to investigate the likelihood that an individual will engage in a knowledge-exchange activity with each of the sectors as a function of a set of explanatory variables. The dependent variable in all cases is binary and equal to one if the individual is involved in an activity with the sector and zero otherwise. Consistent with our discussion in Sect. 3, the explanatory variables included in the analysis are individual characteristics such as age and career status, whether the academic is female, the academic discipline that the individual represents, the type of research the academic is mainly involved in, whether the academic has previous experience in the private, public and third sectors, whether the academic is mainly involved in teaching, research or both teaching and research, as well as institutional support factors and spatial characteristics. A full list of the variables included in the analysis, with corresponding data sources, is provided in Table 10.4 of Appendix. We now discuss the empirical results in detail.

5 Patterns of Academic Interactions Outside Academia

5.1 Descriptive Statistics

As discussed in Sect. 2, the innovation literature has acknowledged the links of academia with businesses, government and nongovernment organisations. However, most of the empirical literature on the engagement of academics with non-academic partners is based on interactions with the private sector only. Based on the results of our survey, we argue that this approach may lead to a significant underestimation of the extent of interactions between academia and external organisations. Table 10.1 shows the percentage of academics who report their involvement with the private, public and third sectors. It shows that proportion of academics who interact with private firms (41 %) is noticeably lower than that for academics involved with public and not-for-profit organisations (52 % and 44 %, respectively).

Table 10.1 also breaks down academic interactions by discipline. The subjects with the highest percentage of interactions with the private sector are engineering and the physical sciences (55 %) and business and media (63 %). This result is as expected, although the value for business and media is very high, suggesting that there is a substantial amount of interaction between business schools and the private sector. The figures for the public sector are also as expected, with the health sciences (64 %), social sciences (63 %) and education (70 %) having the highest

Table 10.1 Academic interactions with external organisations, by subject and type of partner organisation (percentage of academics)

Subject	Private sector	Public sector	Third sector
Health sciences	38.5	64.3	56.8
Biological sciences	41.9	39.5	42.7
English and physical sciences	54.7	43.6	26.0
Social sciences	31.6	62.7	50.5
Business and media	62.6	52.9	41.0
Humanities	21.7	34.9	43.7
Creative arts	47.1	42.3	52.2
Education	28.8	69.9	49.9
All subjects	40.5	52.2	44.3

rates of involvement. The results for the third sector (including voluntary organisations, social enterprises and charities) are most interesting; the highest collaborators are academics in the health sciences (57 %) and the creative arts (52 %). In this context, it is useful to refer to a comment from an academic working in medical research, who remarked in our survey upon the increasing importance of funding from charitable organisations to support research in the health sciences. This is seen by the respondent and his peers as a better alternative to funding from private or public sector organisations, which may come with strings attached or otherwise be restrictive in terms of the type of research undertaken.

As we investigate the effects of location on the extent of academic interactions, Table 10.2 presents the patterns of activities by region. There are no significant outliers for interactions with the private sector, although the East of England region has a higher percentage of interactions (45 %). The results for the public sector reveal that Wales (55 %) and Northern Ireland (55 %) have higher than average figures. These are perhaps due to the high proportion of governmental organisations linked to devolved administrations in these regions, although the result for Scotland is slightly below the UK average, as is the result for London. Yorkshire and the Humber also have a noticeably higher than average percentage of interactions with the public sector (56 %). The results for the third sector indicate that a high proportion of London-based academics interact with third sector organisations (47 %), while the figure is also high for Northern Ireland (49 %). This last result is in keeping with evidence that suggests that the third sector plays a greater role in Northern Ireland than in the other UK regions (Donnelly-Cox et al. 2001).

5.2 Regression Results

We next explore the incidence of academic interactions with the private, public and third sectors as a function of individual, institutional and spatial characteristics using probit regressions. The results are reported in Table 10.3. The regression

Table 10.2 Academic interactions with external organisations, by region and type of partner (percentage of academics)

Region	Private sector	Public sector	Third sector
London	41.1	50.6	47.2
South East	38.8	51.2	45.1
South West	40.3	54.3	45.4
East of England	44.6	51.2	40.7
East midlands	39.6	49.0	38.9
West midlands	38.4	54.2	43.5
North East	38.8	52.3	46.5
North West	40.5	52.0	45.0
Yorkshire and the Humber	42.5	56.2	44.0
Wales	41.5	54.7	46.1
Scotland	39.6	51.6	41.2
Northern Ireland	40.8	54.8	48.5
All regions	40.5	52.2	44.3

coefficients are marginal effects, which can be interpreted as the change in the probability that an individual is involved in the activity as a result of a unit change in each independent, continuous variable. For discrete explanatory variables the coefficients report the discrete change in the probability as the variable changes from 0 to 1.

We argue in Sect. 3 that some of the obstacles to interactions with the private sector, for instance, career status, gender and the type of research, may not be relevant to activities with the public and third sectors. With respect to the career life cycle, we find that, with the exception of the 30–39 age group, age has no effect on interactions with the private sector. However, age is important for activities with the public and third sectors, with older academics being more likely to engage in these activities. The effect of status is similar to previous results; higher status is associated with more academic interactions, across all sectors.

When it comes to private sector activities, we find negative effects of gender which are consistent with the previous studies of academics. However, the gender effect is positive in the case of public and third sector activities, after controlling for other individual and institutional determinants. Combined these results provide support for our earlier discussion on female academics being less likely to work in profit-seeking segments of the economy and demonstrating a more benevolent approach in their interactions with external organisations.

The results for subject and type of research are as expected. Academics in the biological sciences, engineering and the physical sciences are more likely to interact with the private sector, while academics in the health sciences (the reference category) are more likely to interact with the public and third sectors. Being involved in applied or user-inspired research also leads to higher rates of interaction with all sectors, relative to basic research.

The literature on academic entrepreneurship has identified previous experience as an important determinant of subsequent ventures. This finding is further confirmed

Table 10.3 Probit regressions for different types of partner organisation, incorporating individual, institutional and regional characteristics (reporting marginal effects)

	Private sector	Public sector	Third sector
Individual characteristics			
Age: under 30[a]			
Age: 30–39	0.030*	0.046***	0.016
	(0.018)	(0.017)	(0.018)
Age: 40–49	0.021	0.065***	0.064***
	(0.018)	(0.018)	(0.018)
Age: 50 and over	0.005	0.081***	0.085***
	(0.019)	(0.018)	(0.019)
Position: professor	0.243***	0.261***	0.170***
	(0.022)	(0.019)	(0.022)
Position: reader, senior staff	0.138***	0.130***	0.088***
	(0.022)	(0.021)	(0.022)
Position: lecturer	0.079***	0.034	0.018
	(0.022)	(0.021)	(0.021)
Position: researcher	0.074***	0.076***	0.018
	(0.021)	(0.020)	(0.020)
Position: assistant staff[a]			
Manager	0.112***	0.127***	0.059***
	(0.008)	(0.008)	(0.008)
Female	−0.090***	0.014*	0.052***
	(0.008)	(0.008)	(0.008)
Subject: health sciences[a]			
Subject: biological sciences	0.099***	−0.136***	−0.051***
	(0.015)	(0.015)	(0.014)
Subject: English and physical sciences	0.170***	−0.100***	−0.230***
	(0.013)	(0.013)	(0.011)
Subject: social sciences	−0.075***	0.060***	−0.046***
	(0.012)	(0.013)	(0.012)
Subject: business and media	0.144***	−0.065***	−0.141***
	(0.018)	(0.017)	(0.016)
Subject: humanities	−0.109***	−0.161***	−0.069***
	(0.014)	(0.015)	(0.014)
Subject: creative arts	0.018	−0.132***	−0.039**
	(0.020)	(0.020)	(0.019)
Subject: education	−0.120***	0.068***	−0.094***
	(0.015)	(0.018)	(0.016)
Basic research[a]			
User-inspired research	0.183***	0.135***	0.086***
	(0.010)	(0.010)	(0.010)
Applied research	0.250***	0.230***	0.147***
	(0.010)	(0.010)	(0.010)
Other type of research	0.136***	0.061***	0.042**
	(0.022)	(0.021)	(0.021)
Employed in small company	0.089***	−0.020**	−0.019*
	(0.010)	(0.010)	(0.010)

(continued)

Table 10.3 (continued)

	Private sector	Public sector	Third sector
Owned small company	0.194***	0.029**	0.048***
	(0.011)	(0.012)	(0.012)
Employed in large company	0.105***	−0.046***	−0.029***
	(0.010)	(0.010)	(0.010)
Employed in public sector	−0.034***	0.166***	0.039***
	(0.010)	(0.009)	(0.010)
Employed in third sector	−0.033***	0.061***	0.337***
	(0.011)	(0.011)	(0.010)
Not previously employed	−0.049***	−0.070***	−0.019*
	(0.011)	(0.012)	(0.012)
Research only	−0.033***	0.013	−0.025**
	(0.012)	(0.012)	(0.012)
Teaching only	−0.008	−0.021	−0.022
	(0.027)	(0.028)	(0.027)
Both research and teaching[a]			
Institutional characteristics			
Weight given to research	0.021**	0.062***	0.013
	(0.011)	(0.011)	(0.011)
Weight given to commercialisation	0.076***	0.012	−0.040***
	(0.015)	(0.015)	(0.015)
In-house licensing capability	0.013	0.021	−0.008
	(0.021)	(0.022)	(0.021)
Proportion of business reps.	−0.014	0.082**	−0.029
	(0.036)	(0.037)	(0.036)
Proportion of public sector reps.	−0.015	0.034	0.051**
	(0.023)	(0.023)	(0.023)
Proportion of third sector reps.	−0.033	0.075	−0.063
	(0.057)	(0.058)	(0.057)
External licensing capability	0.029	0.032	0.004
	(0.026)	(0.026)	(0.025)
No licensing undertaken[a]			
Contracting system	−0.030***	0.008	−0.021*
	(0.011)	(0.012)	(0.011)
Staff indemnity insurance	0.009	−0.056**	−0.065***
	(0.023)	(0.024)	(0.024)
Commercialisation company	0.003	0.144***	0.116***
	(0.040)	(0.038)	(0.040)
Commercialisation department	−0.010	0.144***	0.098**
	(0.038)	(0.038)	(0.038)
Both company and department	−0.014	0.155***	0.107***
	(0.039)	(0.039)	(0.039)
No commercialisation facilities[a]			
Spatial characteristics			
Population density (ln)	0.006	−0.004	0.005
	(0.005)	(0.005)	(0.005)

(continued)

Table 10.3 (continued)

	Private sector	Public sector	Third sector
Distance to London (ln)	−0.014*	−0.024***	−0.003
	(0.008)	(0.009)	(0.008)
London	−0.021	−0.101***	0.006
	(0.037)	(0.038)	(0.038)
South-east	−0.001	0.015	0.032
	(0.021)	(0.021)	(0.021)
South-west	0.017	0.086***	0.066***
	(0.023)	(0.023)	(0.023)
East of England	0.033*	0.029	−0.009
	(0.024)	(0.024)	(0.023)
East midlands[a]			
West midlands	−0.017	0.027	−0.011
	(0.022)	(0.022)	(0.022)
North-east	0.009	0.045*	0.070***
	(0.024)	(0.024)	(0.024)
North-west	0.019	0.030	0.029
	(0.020)	(0.020)	(0.020)
Yorkshire and the Humber	0.038*	0.075***	0.015
	(0.020)	(0.020)	(0.020)
Wales	0.041*	0.072***	0.052**
	(0.025)	(0.024)	(0.025)
Scotland	0.012	0.075***	0.025
	(0.022)	(0.021)	(0.022)
Northern Ireland	0.052*	0.085***	0.090***
	(0.031)	(0.030)	(0.031)
Observations	20,514	20,379	20,369
Likelihood ratio	4,196.23***	4,010.58***	3,320.49***
Pseudo R^2	0.15	0.14	0.12

Note: Standard errors in parentheses
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$
[a]Reference category

by our results. Having owned a small company is associated with higher rates of interaction across all sectors, especially with the private sector, while having been employed in the public or third sectors has a positive effect on activities with those sectors, but a negative effect on interactions with the private sector. Not having been employed outside academia is negative for all types of interaction. In terms of roles within the higher education institution, being on a research-only contract has a negative effect on both private and third sector activities.

Moving on to the institutional factors, we find that these have, in general, less of an effect on academic interactions. A higher weight given by the institution to research is associated with more private and public sector interactions, while a

greater weight to commercialisation activities has a positive effect on private sector activities and a negative effect on third sector activities. However, having a dedicated commercialisation department or company is positive for public and third sector activities, but has no effect on private sector activities. Requiring all staff to use in-house contracting and indemnity insurance systems is negative for all types of activities.

These results are interesting in a sense that they indicate that for academics interacting with the public and third sectors it is still very important to receive positive signals from their institution about availability of commercialisation facilities, which may be considered useful for a wider set of interactions, and as long as there is no compulsory procedure involved. At the same time those who interact with the private sector may not find these facilities important. Similarly, the inclusion of private sector representatives in the institutional governing body sends a positive signal to those working with the public sector and has no effect on private sector interactions. For those who are interacting with the third sector, it is the presence of public sector representatives which sends a positive signal, probably reflecting the increasing interconnection between the two sectors.

As far as spatial factors are concerned, we find a very limited effect on academic interactions across all sectors. Population density has no effect at all, whereas distance to London, as a rough measure of closeness to partners and networks, is negative for all types of activities, although only statistically significant for private and public sector activities.

6 Conclusion and Discussion

The academic and policy literatures have increasingly acknowledged that university engagement with the economy extends well beyond the private sector and includes the public and third (or not-for-profit) sectors. This observation, however, is not adequately reflected in most of the literature on university–industry interactions which focuses on issues related to the translation of university research for use in the private sector. As a consequence, little is known about the extent and factors driving academic interactions with public and third sector organisations, and there is a risk that government and institutional policies may underestimate the importance of these activities and, therefore, underprovide support mechanisms for academic interactions which are not immediately driven by profit considerations.

In this chapter we challenge the narrow interpretation of an interface between the university and external organisations by exploring the extent and determinants of academic interactions with all sectors, including private, public and not-for-profit organisations. We find that the involvement of academics with private firms is substantial but less widespread than that with public and third sector organisations. This confirms our hypothesis that the contribution of the university to the economy and innovation processes should be conceptualised in a wider context of private, public and social innovation.

When it comes to the factors driving academic interactions, our results not only support many of the findings from the previous studies on university-business links but also reveal a number of interesting and surprising conclusions. These are mainly related to the impact of individual and institutional factors on public and third sector activities.

We find that individual characteristics are more important than institutional characteristics in explaining academic interactions. In particular, we find that the subject area is an important determinant. It is notable that a great deal of activity with not-for-profit organisations is carried out by academics from the health sciences. The results for gender are also very telling indicating that female academics are much more likely to be involved with the public and third sectors, as compared to interactions with private businesses.

Involvement in multiple roles within academia also leads to interesting findings. Being involved in research only has a negative effect on private and third sector activities. This implies that traditional university roles that combine both teaching and research, as opposed to the current trend of teaching- or research-only appointments, would be more beneficial for third stream activities and hence for the university's role in private and social innovation.

Institutional factors are less important than individual factors, but a few stand out. We find that a greater weight given by the institution to commercialisation can be detrimental to interactions with the public and third sectors, while the provision of dedicated facilities has a positive effect, as long as these are not made compulsory for all types of activities. This would suggest that universities should focus on providing facilities to simplify the process of interactions with outside organisations, without making the use of these facilities compulsory, and adopt a more flexible approach to its definition of knowledge transfer, to encourage interactions beyond the private sector.

Our results suggest that more institutional support could be provided to academics willing to engage with private, public and third sector organisations. Moreover, policymakers and university administrators should be concerned that the presence of commercialisation facilities does not necessarily translate into greater involvement of academics with private firms. Although the results do indicate that TTOs have started acknowledging the importance of public and third sector activities by signalling that their knowledge transfer facilities can be available to academic interactions with no immediate financial reward, but of a significant public and social benefit, still much needs to be done by the university to help academics to engage with public and social innovation.

Finally, we find only a limited scope for spatial characteristics such as population density and distance to London. Being located in a busy area, with many opportunities for networking and informal kinds of interaction, does not appear to significantly affect the probability of academic interaction with any of the sectors. Distance to London has a negative effect on private and public sector activities, indicating that closeness to the capital has a positive effect on interaction with these sectors.

Variable Included in the Analysis

Table 10.4 Description of the variables used in the analysis

Variable	Data source	Description
Dependent variables		
Private sector	CBR Survey of Academics (2009)	Whether the respondent has been engaged with private sector companies
Public sector	CBR Survey of Academics (2009)	Whether the respondent has been engaged with public sector organisations
Third sector	CBR Survey of Academics (2009)	Whether the respondent has been engaged with charitable or voluntary organisations
Individual characteristics		
Age: under 30[a]	CBR Survey of Academics (2009)	Whether the respondent belongs to the age band
Age: 30–39		
Age: 40–49		
Age: 50 and over		
Position: professor	CBR Survey of Academics (2009)	Whether the respondent holds a given position in the institution. Senior staff includes senior research and teaching staff; assistant staff includes research and teaching assistants
Position: reader, senior staff		
Position: lecturer		
Position: researcher		
Position: assistant staff[a]		
Female	CBR Survey of Academics (2009)	Whether the respondent is female
Manager	CBR Survey of Academics (2009)	Whether the respondent has management responsibility within the institution
Basic research[a]	CBR Survey of Academics (2009)	Main type of research conducted by the respondent (Stokes 1997). Basic research has no application or use in view; user-inspired research is inspired by considerations of use; and applied research is directed towards an individual, group or societal need or use
User-inspired research		
Applied research		
Other type of research		
Research only	CBR Survey of Academics (2009)	Whether the respondent is involved in research, teaching or both research and teaching. Respondents not involved in any teaching or research were excluded from the analysis
Teaching only		
Both research and teaching[a]		
Employed in small company	CBR Survey of Academics (2009)	Whether the respondent has previously been employed in the private, public or third sector or has owned a small company
Owned small company		
Employed in large company		
Employed in public sector		
Employed in third sector		
Not previously employed		

(continued)

Table 10.4 (continued)

Variable	Data source	Description
Subject: health sciences[a]	CBR Survey of Academics (2009)	Main subject area, as defined by the respondent
Subject: biological sciences		
Subject: English and physical sciences		
Subject: social sciences		
Subject: business and media		
Subject: humanities		
Subject: creative arts		
Subject: education		
Institutional characteristics		
Weight given to research	CBR Survey of Academics (2009)	Average value of the respondents' perception of the importance (on a 1–5 scale) given by their institution to research and commercialisation activities, respectively
Weight given to commercialisation		
Proportion of staff using TTO	CBR Survey of Academics (2009)	Percentage of respondents within each institution who have used the technology transfer office, knowledge transfer office or similar services, within the past 3 years
In-house licensing capability	HE-BCI Survey (2007)	Whether the institution has an in-house licensing capability for its intellectual property, uses an external agency or does not undertake action on licensing
External licensing capability		
No licensing undertaken[a]		
Contracting system	HE-BCI Survey (2007)	Whether the institution has a dedicated unit that provides a contracting system for all staff business and community interaction activities and whether it provides staff indemnity insurance
Staff indemnity insurance		
No commercialisation facilities[a]	HE-BCI Survey (2007)	Whether the institution has a commercialisation company or department to manage consulting links and other external interactions
Commercialisation company		
Commercialisation department		
Both company and department		
Proportion of business reps.	HE-BCI Survey (2007)	The proportion of business, public sector and third sector representatives on the institution's governing body
Proportion of public sector reps.		
Proportion of third sector reps.		

(continued)

Table 10.4 (continued)

Variable	Data source	Description
Spatial characteristics		
Population density	ONS (2005)	The resident population density (population per hectare) in the local authority district or unitary authority where the respondent's institution is located. The population estimate is based on the 2001 census, but has been adjusted for migration
Distance to London	Own calculations based on institution postcodes	Distance from the institution to the centre of London (in km)
London South-east South-west East of England East Midlands[a] West Midlands North-east North-west Yorkshire and the Humber Wales Scotland Northern Ireland	CBR Survey of Academics (2009)	Whether the respondent's institution is located in a given Government Office Region (GOR)

Note: CBR Survey of Academics (2009) refers to the "Cambridge Centre for Business Research Survey of Knowledge Exchange Activity by United Kingdom Academics, 2005–2009", available from the UK Data Archive, archive no. SN 6462 (Hughes et al. 2010a)
[a]Used as reference category in the regression analysis

References

Abramovsky L, Harrison R, Simpson H (2007) University research and the location of business R&D. Econ J 117:114–141

Abreu M, Grinevich V, Hughes A, Kitson M (2008) Universities, business and knowledge exchange. Council for Industry and Higher Education (CIHE) and Centre for Business Research (CBR)

Abreu M, Grinevich V, Hughes A, Kitson M (2009) Knowledge exchange between academics and the business, public and third sectors. UK Innovation Research Centre, University of Cambridge and Imperial College London

Agrawal A, Henderson R (2002) Putting patents in context: exploring knowledge transfer from MIT. Manag Sci 48:44–60

Ambos TC, Mäkelä K, Birkinshaw J, D'Este P (2008) When does university research get commercialized? Creating ambidexterity in research institutions. J Manag Stud 45:1424–1447

Anselin L, Varga A, Acs Z (1997) Local geographic spillovers between university research and high technology innovations. J Urban Econ 42:422–448

Arundel A, Geuna A (2004) Proximity and the use of public science by innovative European firms. Econ Innov New Technol 13:559–580

Azagra-Caro JM, Archontakis F, Gutierrez-Gracia A, Fernandez-de-Lucio I (2006) Faculty support for the objectives of university–industry relations versus degree of R&D cooperation: the importance of regional absorptive capacity. Res Policy 35:37–55

Azoulay P, Ding W, Stuart T (2007) The determinants of faculty patenting behavior: demographics or opportunities? J Econ Behav Organ 63:599–623
Baldini N (2008) Negative effects of university patenting: myths and grounded evidence. Scientometrics 75:289–311
Baldini N, Grimaldi R, Sobrero M (2007) To patent or not to patent? A survey of Italian inventors on motivations, incentives, and obstacles to university patenting. Scientometrics 70:333–354
Belkhodja O, Landry R (2007) The triple-helix collaboration: why do researchers collaborate with industry and the government? What are the factors that influence the perceived barriers? Scientometrics 70:301–332
Bercovitz J, Feldman M (2003) Technology transfer and the academic department: Who participates and why? Paper presented at the DRUID Summer Conference 2003, Copenhagen, 12–14 June 2003
Bush V (1945) Science: the endless frontier. US Government Printing Office, Washington, DC
Campbell TID, Slaughter S (1999) Faculty and administrators' attitudes toward potential conflicts of interest, commitment, and equity in university-industry relationships. J High Educ 70:309–352
Carayol N (2007) Academic incentives, research organization and patenting at a large French university. Econ Innov New Technol 16:119–138
Christman JJ, Hynes T, Fraser S (1995) Faculty entrepreneurship and economic development: the case of the University of Calgary. J Bus Venturing 10:267–281
Cohen WM, Nelson RR, Walsh JP (2002) Links and impacts: the influence of public research on industrial R&D. Manag Sci 48:1–123
Collins SA, Wakoh H (2000) Universities and technology transfer in Japan: recent reforms in historical perspective. J Technol Transf 25:213–222
Cooke P (2001) Regional innovation systems, clusters, and the knowledge economy. Ind Corp Change 10:945–974
Cooke P (2002) Knowledge economies. Clusters, learning and cooperative advantage. Routledge, London
Cooke P, Uranga MG, Etxebarria G (1997) Regional innovation systems: institutional and organisational dimensions. Res Policy 26:475–491
D'Este P, Iammarino S (2010) The spatial profile of university-business research partnerships. Pap Reg Sci 89:335–350
D'Este P, Patel P (2007) University-industry linkages in the UK: what are the factors underlying the variety of interactions with industry. Res Policy 36:1295–1313
D'Este P, Perkmann M (2010) Why do academics engage with industry? The entrepreneurial university and individual motivations. J Technol Transf 36(3):316–339
Debackere K, Veugelers R (2005) The role of academic technology transfer organizations in improving industry science links. Res Policy 34:321–342
Del Campo AA, Sparks A, Hill RC, Keller RT (1999) The transfer and commercialisation of university-developed medical imaging technology: opportunities and problems. IEEE Trans Eng Manag 46(3):289–299
Dietz JS, Bozeman B (2005) Academic careers, patents, and productivity: industry experience as scientific and technical human capital. Res Policy 34:349–367
Ding WW, Murray F, Stuart TE (2006) Gender differences in patenting in the academic life sciences. Science 313:665–667
Donnelly-Cox G, Donoghue F, Hayes T (2001) Conceptualizing the third sector in Ireland, North and South. Voluntas 12:195–204
Etzkowitz H (2003) Research groups as 'quasi-firms': the invention of the entrepreneurial university. Res Policy 32:109–121
Etzkowitz H, Webster A, Gebhardt CA, Terra BRC (2000) The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. Res Policy 29:313–330

Faulkner W, Senker J (1994) Making sense of diversity: public-private sector research linkages in three technologies. Res Policy 23:673–695
Feldman M (1994) The geography of innovation. Kluwer, Amsterdam
Freeman C (1987) Technology policy and economic performance: lessons from Japan. Pinter, London
Friedman J, Silberman J (2003) University technology transfer: do incentives, management and location matter? J Technol Transf 28:17–30
Geuna A, Nesta L (2006) University patenting and its effects on academic research: the emerging European evidence. Res Policy 35:790–807
Gulbrandsen M, Smeby JC (2005) Industry funding and university professors' research performance. Res Policy 34:932–950
Harmon B, Ardishvili A, Cardozo R, Elder T, Leuthold J, Parshall J, Raghian M, Smith D (1997) Mapping the university technology transfer process. J Bus Venturing 12:423–434
HE-BCI (2007) The Higher Education—Business and Community Interaction Survey 2007–08. Higher Education Funding Council for England (HEFCE)
Henderson R, Jaffe A, Trajtenberg M (1998) Universities as a source of commercial technology: a detailed analysis of university patenting, 1965–1988. Rev Econ Stat 80:119–127
Hughes A, Kitson M, Abreu M, Grinevich V, Bullock A, Milner I (2010) Cambridge Centre for Business Research Survey of Knowledge Exchange Activity by United Kingdom Academics 2005–2009. UK Data Archive Study No. 6462
Jacob M, Lundqvist M, Hellsmark H (2003) Entrepreneurial transformations in the Swedish university system: the case of Chalmers university of Technology. Res Policy 32:1555–1568
Jacobsson S (2002) Universities and industrial transformation: an interpretative and selective literature study with special emphasis on Sweden. Sci Public Pol 29:345–365
Jaffe A (1989) Real effects of academic research. Am Econ Rev 79:957–970
Jensen R, Thursby M (2003) Proofs and prototypes for sale: the licensing of university inventions. Am Econ Rev 91:240–259
Kenney M, Goe WR (2004) The role of social embeddedness in professorial entrepreneurship: a comparison of electrical engineering and computer science at UC Berkeley and Stanford. Res Policy 33:691–707
Kline SJ, Rosenberg N (1986) An overview of innovation. In: Landau R, Rosenberg N (eds) The positive sum strategy: harnessing technology for economic growth. National Academy Press, Washington, DC
Klofsten M, Jones-Evans D (2000) Comparing academic entrepreneurship in Europe—the case of Sweden and Ireland. Small Bus Econ 14:299–309
Landry R, Nabil A, Ouimet M (2005) A resource-based approach to knowledge-transfer: evidence from Canadian university researchers in natural sciences and engineering. Paper presented at the DRUID Tenth Anniversary Summer Conference, Copenhagen, 27–29 June 2005
Laursen K, Reichstein T, Salter A (2010) Exploring the effect of geographical proximity and university quality on university–industry collaboration in the United Kingdom. Reg Stud 45 (4):507–523
Lee YS (1996) 'Technology transfer' and the research university: a search for the boundaries of university-industry collaboration. Res Policy 25:843–863
Lester R (2003) Universities and local systems of innovation: a strategy approach. Paper presented at the Workshop on High-Tech Business: Clusters, Constraints, and Economic Development, Robinson College, University of Cambridge
Levin SG, Stephan PE (1991) Research productivity over the life cycle: evidence for academic scientists. Am Econ Rev 81:114–132
Link AN, Siegel DS (2005) Generating science-based growth: an econometric analysis of the impact of organizational incentives on university–industry technology transfer. Eur J Financ 11:169–181
Link AN, Siegel DS, Bozeman B (2007) An empirical analysis of the propensity of academics to engage in informal university technology transfer. Ind Corp Change 16:641–655

Lockett A, Wright M (2005) Resources, capabilities, risk capital and the creation of university spin-out companies. Res Policy 34:1043–1057
Louis KS, Jones LM, Anderson MS, Blumenthal D, Campbell EG (2001) Entrepreneurship, secrecy, and productivity: a comparison of clinical and non-clinical life sciences faculty. J Technol Transf 26:233–245
Lundvall B-A (ed) (1992) National systems of innovation. Pinter, London
Macho-Stadler I, Pérez-Castrillo P, Veugelers R (2007) Licensing of university inventions: the role of a technology transfer office. Int J Ind Organ 25:483–510
Mansfield E (1995) Academic research underlying industrial innovations: sources, characteristics and financing. Rev Econ Stat 77:55–65
Mansfield E, Lee J-Y (1996) The modern university: contributor to industrial innovation and recipient of industrial R&D support. Res Policy 25:1047–1058
Markman GD, Gianiodis PHP, Balkin DB (2004) Entrepreneurship from the ivory tower: do incentive systems matter? J Technol Transf 29:353–364
Markman GD, Phan PH, Balkin DB, Gianiodis PT (2005) Entrepreneurship and university-based technology transfer. J Bus Venturing 20:241–263
Morgan RP, Kruytbosch C, Kannankutty N (2001) Patenting and invention activity of U.S. scientists and engineers in the academic sector: comparisons with industry. J Technol Transf 26:173–183
Mosey S, Wright M (2007) From human capital to social capital: a longitudinal study of technology-based academic entrepreneurs. Entrep Theory Pract 31:909–935
Mowery DC, Sampat BN (2005) Universities in national innovation systems. In: Fagerberg J, Mowery DC, Nelson RR (eds) The Oxford handbook of innovation. Oxford University Press, Oxford
Mowery DC, Nelson RR, Sampat BN, Ziedonis AA (2001) The growth of patenting and licensing by the U.S. universities; an assessment of the effects of the Bayh-Dole act of 1980. Res Policy 30:99–119
Murray F (2002) Innovation as co-evolution of scientific and technological networks: exploring tissue engineering. Res Policy 31:1389–1403
Murray F, Graham L (2007) Buying science and selling science: gender differences in the market for commercial science. Ind Corp Change 16:657–689
Nelson RR (ed) (1993) National innovation systems: a comparative analysis. Oxford University Press, New York
ONS (2005) Mid-year population estimates 2005 for UK, England, Wales, Scotland and Northern Ireland. Office for National Statistics, UK
Owen-Smith J, Powell WW (2001) To patent or not: faculty decisions and institutional success at technology transfer. J Technol Transf 26:99–114
Powers JB, McDougall PP (2005) Policy orientation effects on performance with licensing to start-ups and small companies. Res Policy 34:1028–1042
Roberts EB (1991) Entrepreneurs in high technology. Lessons from MIT and beyond. Oxford University Press, New York/Oxford
Rothaermel FT, Agung SD, Jiang L (2007) University entrepreneurship: a taxonomy of the literature. Ind Corp Change 16:691–791
Schartinger D, Schibany A, Gassler H (2001) Interactive relations between universities and firms: empirical evidence for Austria. J Technol Transf 26:255–269
Seashore Louis K, Blumenthal D, Gluck ME, Stoto MA (1989) Entrepreneurs in academe: an exploration of behaviors among life scientists. Adm Sci Q 34:110–131
Shane S (2004) Academic entrepreneurship: university spinoffs and wealth creation. Edward Elgar, Cheltenham/Northampton
Siegel DS, Waldman DA, Atwater LE, Link AN (2003) Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. J High Technol Manag Res 14:111–133

Siegel DS, Waldman DA, Atwater LE, Link AN (2004) Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. J Eng Technol Manag 21:115–142

Siegel DS, Veugelers R, Wright M (2007) Technology transfer offices and commercialization of university intellectual property: performance and policy implications. Oxford Rev Econ Pol 23:640–660

Stephan PE (2001) Educational implications of university-industry technology transfer. J Technol Transf 26:199–205

Stephan PE, El-Ganainy A (2007) The entrepreneurial puzzle: explaining the gender gap. J Technol Transf 32:475–487

Stephan PE, Gurmu S, Sumell A, Black G (2007) Who's patenting in the university? Evidence from a survey of doctorate recipients. Econ Innov New Technol 16:71–99

Stokes DE (1997) Pasteurs quadrant: basic science and technological innovation. Brookings Institution Press, Washington, DC

Thursby JG, Thursby MC (2003) Patterns of research and licensing activity of science and engineering faculty. In: Ehrenberg R, Stephan P (eds) Science and the university. University of Wisconsin Press, Madison

Thursby JG, Thursby MC (2005) Gender patterns of research and licensing activity of science and engineering faculty. J Technol Transf 30:343–353

Thursby JG, Jensen RA, Thursby MC (2001) Objectives, characteristics and outcomes of university licensing: a survey of major U.S. universities. J Technol Transf 26:59–70

Whittington KB, Smith-Doerr L (2005) Gender and commercial science: women's patenting in the life sciences. J Technol Transf 30:355–370